Summer 2013

The Effects of Self-Regulated Learning on Community College Students' Metacognition and Achievement in Developmental Math Courses

Karen D. Y. Campbell
Old Dominion University

THE EFFECTS OF SELF-REGULATED LEARNING ON COMMUNITY COLLEGE STUDENTS' METACOGNITION AND ACHIEVEMENT IN DEVELOPMENTAL MATH COURSES

by

Karen D. Y. Campbell
B.S., May 1991, University of Richmond
M.Ed., May 1993, James Madison University

A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

HIGHER EDUCATION

OLD DOMINION UNIVERSITY
August 2013

Approved by:

Dr. Linda Bol (Chair)

Dr. Cheng-Jyn Yen (Member)

Dr. Dennis Gregory (Member)

ABSTRACT

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Karen D. Y. Campbell
Old Dominion University, 2013
Director: Dr. Linda Bol

The effects of training in self-regulation on metacognition and math achievement were investigated in this study. The moderator effect of gender, age and ethnicity on the relationships between training and the outcomes of metacognition and math achievement were also explored. The participants for this study were 116 community college students enrolled in developmental math courses during the spring semester. Teachers volunteered their classes for the study; there were a total of 16 classes participating in the study over two four-week terms. Classrooms were bifurcated and students were randomly assigned to the treatment and control groups. Participants in the treatment group completed four self-regulated learning exercises modeled after Zimmerman's (2002) cyclical self-regulated learning model. The exercises were completed weekly and repeated for a total of three weeks. Participants from both the treatment and control group completed a final exam to measure math achievement and an abbreviated version of the MSLQ to measure metacognition skills the last week of class. There was a significant difference between the two groups, suggesting that training in self-regulated learning improves math achievement and metacognitive skills of students in developmental math courses. Further investigation of the effects of training in self-regulated learning on math achievement and metacognition was explored by math subject. A significant difference was found in the

lower level developmental math classes for Unit 2 (Decimals and Percent). Students in the treatment group had higher math achievement scores. For Unit 3 (Algebra Basics), there was a significant difference on the MSLQ scores (metacognition) favoring the treatment group. The findings suggest that training in self-regulated learning improves math achievement and metacognition levels of students taking the lower level developmental math courses. Moderator effects of the demographic variables were not observed, indicating that neither the relationship between training in self-regulated learning and math achievement nor the relationship between training in self-regulation learning and metacognition varied across gender, ethnicity, and age.

ACKNOWLEDGMENTS

There are several people I would like to thank for their encouragement and support in completing this dissertation. First, I would like to thank the love of my life, my husband, Mr. Carlton Campbell, who sacrificially gave me everything I needed to complete this process. His understanding of the long hours and late nights it takes to earn a doctoral degree was invaluable. I am thankful for his consistent support, encouragement, wisdom and love.

Secondly, I want to thank Dr. Linda Bol, who I believe to be the best committee chair in the world. She was God sent and I thank her for agreeing to mentor and guide me through this process. Her critiques and insight assisted me as I embarked upon this dissertation journey. I am grateful for her commitment to teaching, research and student success.

Thank you to my supportive family who taught me early in life that all things are possible to those who commit themselves to the task at hand and trust God for the rest. I thank them for their dedication, love, support, consistent encouragement and prayers.

To my dear friend and classmate, Dr. Denise Balfour Simpson, I am thankful that we were able to travel this road together. It has been an unforgettable journey and I am honored that our paths crossed. We learned more than we could have ever imagined. Thank you for your support and for making me laugh when I needed it the most.

Finally, thank you to my committee members Dr. Cherng-Jyn Yen and Dr. Dennis Gregory, who provided insightful feedback which helped construct a dissertation that is comprehensive and robust in analysis of the topic.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Math achievement in the United States of America lags behind other countries, such as, Chinese Taipei, Republic of Korea, Singapore, Hong Kong and Japan (National Center for Education Statistics, 2009). In an effort to narrow the gap in achievement between the United States and other countries, educational policies and programs were created to increase math and science achievement in students, starting as early as kindergarten. These policies and programs, such as the *No Child Left Behind Act* and *Achieving the Dream* may have positively impacted student achievement; however, a large portion of underprepared college students are not able to successfully complete the math course sequence necessary for attaining their academic and career goals (Lee, 2012).

Math Achievement Gaps

The math achievement gap in males and females is traced back to kindergarten with males outperforming females in math achievement (Penner & Paret, 2008). Science, technology, engineering and mathematics (STEM) were designed to decrease these gaps, so that once students, in particular females and minorities, enter college they will select careers associated with math and science majors (Afterschool Alliance, 2011). Although the program has been successful in increasing the number of females entering upper level math courses in college and eventually attaining employment in fields requiring a higher level of mathematical competence, there still exists an achievement gap between males and females (Riegle-Crumb & Grodsky, 2010).

Ethnicity differences are also a relevant discussion surrounding math achievement in the United States, with more African American and Hispanic students being outperformed by Caucasian students in math courses as early as kindergarten (Bembenutty, 2007; Riegle-Crumb & Grodsky, 2010). This achievement gap has been attributed to a difference in socioeconomic background, school systems and parental education (Lee, 2012). Although other reasons for the disparities have been cited in the literature, the results from the National Assessment of Educational Progress (NAEP), a national assessment instrument used by the United States to assess math achievement amongst 8th graders, reports the disparity with a 31 point difference between the average scores of Caucasian and African American students and a 24 point difference between average scores of Caucasian and Hispanic students (National Center for Education Statistics, 2011).

There are programs and policies directed at addressing the issues of disparity in math achievement in K-12, however, there are still a large proportion of students who graduate from high school with math deficiencies (Lee, 2012). Literature defines these students as underprepared or not college ready (Markus & Zeitlin, 1998). These students have increasingly found the open access and affordability missions of the community colleges a doorway to attaining their academic goals. However, once through the door, many of these students find passing developmental courses one of the greatest hurdles to achieving success (Bahr, 2008).

Developmental Education

History of developmental education. Discussions concerning the role of developmental education in higher education date back to the 19th century, with the

University of Michigan and Yale on the opposing side and Harvard offering a supportive stance, by suggesting the American college should teach what the elementary schools fail to teach (Davis & Palmer, 2010). The differing views of the role of developmental education in higher education would continue for the next 160 years. Legislation, such as the *Morrill Act of 1890* (ch.841, 26 Stat.417, 7 U.S.C. 322 et seq.); the *Serviceman's Readjustment Act of 1944* (Pub. L. No. 78-346, 58 Stat. 284), also known as the G. I. Bill; the *Civil Rights Acts of 1964* (Pub. L. No. 88-352, 78 Stat. 241); and the *Higher Education Act of 1965* (Pub. L. No. 89-329), contributed to the influx of students who would need remedial education attending colleges and universities in America.

The federal government's commitment to the expansion of educational opportunity for all Americans forced institutions of higher education to develop formal developmental education programs (Davis & Palmer, 2010). The programs would offer students, who otherwise might not have the opportunity to attend college, the opportunity to improve deficient skills through developmental courses.

Developmental education in the community college. Community colleges have an open door policy; unfortunately, this policy does not translate to access to college-level coursework (Bahr, 2008). Students who enter postsecondary institutions underprepared in math, English and writing will be subject to developmental courses. According to Bahr (2008), developmental education provides opportunities to students who may not otherwise have the ability to attain the prerequisite minimal skills deemed necessary to be successful in a college environment. Although students have the opportunity to enroll in developmental courses, much debate remains over whether or not the courses are effective in helping students meet their academic goals. Researchers

Attewell, Lavin, Domina, and Levey (2006) along with Bettinger and Long (2009) suggested developmental education is effective. They found students who took developmental courses were just as likely to attain their academic goals as those who did not take developmental courses. On the contrary, Calcagno and Long (2008) found students in developmental education courses were persistent, but they were less likely to attain a degree in comparison to those who did not take a developmental course.

Students who enrolled in developmental education at a community college, on average, take three remedial courses (Howell, 2011). As community colleges continue to see an increase in enrollment and the number of students requiring some type of remediation, there is a need for empirical evaluations which examine the effectiveness of developmental education and explore how students successfully complete sequential developmental courses.

Developmental math. Developmental math courses are often the gateway courses to successful completion of academic programs at a community college. Students who place in the lower level developmental courses have to take several math courses prior to completing the college level math course required for curriculum completion of their degree program. Developmental math courses typically have the highest withdrawal and failure rate of all college courses (Adelman, 2004). Moreover, 42% of students entering a community college have to take at least one developmental math course ("Fast Facts," 2012). Fifty-seven percent of students entering a Virginia Community College in fall 2007 were recommended for a developmental math course. The large proportion of underprepared students entering a community college suggests the need for strategies and

programs to assist students with successfully navigating through the sequences of math courses (Virginia Community College Systems, 2012).

Redesign of developmental math. The Virginia Community College System (VCCS) recently redesigned developmental math courses for the community college system in an effort to increase the number of students who successfully complete the course and reduce the time that it takes to complete developmental education (Developmental Mathematics Redesign Team, 2010). The redesigned math courses are taught as nine distinct 4-week units. Students are only required to take the units that are necessary for them to develop competency in a specific area. Students can take up to 4 units per semester, allowing for most students to complete all units needed within two semesters (DMRT, 2010). The redesign of the developmental math course offers an opportunity to investigate the effects of self-regulated learning on academic outcomes of students enrolled in developmental math.

Underprepared Student

Robinson (1996) suggested there are three types of underprepared students: academically underprepared, emotionally underprepared, and culturally underprepared; each presents its own set of challenges. For the purposes of this study, the underprepared student is examined solely through the lens of being academically underprepared prior to entering college. Underprepared students have been defined as disadvantaged, high risk, nontraditional developmental and remedial students (Markus & Zeitlin, 1998). Wilmer (2008) suggested underprepared students suffer with issues of motivation, self-esteem and aptitude. These issues propose a challenge for students to become integrated into the academic environment of a college. These students have to take developmental education

courses; the number of courses depends on the developmental education policy at that particular institution.

Many students who are underprepared do not recognize that they are underprepared, which often causes them to not seek the necessary help to become successful in college. Schaffhauser (2009) found that 41% of community college students who were "not directed" toward college completion dropped out during their first year. Self-regulated learning may help students successfully navigate learning in their classes and may assist the underprepared student with connecting to the academic environment and ultimately attaining their academic goals.

Self-Regulated Learning

Self-regulated learning (SRL) is "a proactive process whereby individuals consistently organize and manage their thoughts, emotions, behaviors, and environment in order to attain academic goals" (Ramdass & Zimmerman, 2011, p. 198). Zimmerman's (2002) cyclical model of self-regulation suggests a learner goes through three phases of learning while receiving feedback (see Figure 2.1, p. 28). The learner progresses from forethought (which incorporates goal setting and strategic planning), to the second phase of performance (which incorporates self-instruction and self-monitoring), to the third phase of self-reflection (which incorporates self-reaction and adaption). In addition, self-regulated learning incorporates three components: cognitive, metacognitive and motivational. The cognitive component relates to strategies students use to complete a task which may include rehearsal (repeating words), elaboration (paraphrasing) and organization (finding main ideas within the text) (Cho, 2004). The motivational component incorporates students' beliefs about their abilities and may include self-

efficacy and task value. The metacognitive component involves setting goals and students monitoring their progress through self-reflection (Ramdass & Zimmerman, 2011).

It is important for college students to be self-regulated learners because much of the responsibility for mastering a subject is placed on the student. According to Pintrich (1999), self-regulated learning can be taught. Studies suggest when students are taught self-regulation strategies, they can learn to overcome their weaknesses and be successful learners (Cho, 2004). Self-regulated learning promotes achievement and assists students in learning how to control their learning environment (Montalvo & Torres, 2004). Since lower level achievers tend not to display high levels of self-regulated learning, training in SRL strategies may promote academic achievement in students by offering strategies for comprehending challenging material (Bol & Garner, 2011; Zimmerman, 2002). There is very little research that investigates the impact of self-regulated learning on math achievement of community college students and even fewer studies which examine self-regulated learning strategies by gender, ethnicity and age.

Gender, ethnicity, and age. Of the three demographic variables, gender, ethnicity, and age, there is more research on self-regulated learning strategy use by age with the literature suggesting that adult learners have higher levels of self-regulated learning than younger students. Specifically, Hoyert & O'Dell (2009) found adult learners have higher levels of intrinsic motivation and goal orientation than younger learners. The study correlates with much of the literature which suggests that since adult learners are ready to learn and have depth of experience, they are more likely to exhibit higher levels of metacognitive, motivational and cognitive strategies.

In general, researchers suggest more self-regulated learning strategies are used by females than males (Bezzina, 2010). However, males tend to exhibit higher levels of self-efficacy and intrinsic motivation, which may contribute to their outperforming females in higher level math and science courses. A study specific to underprepared college students at a community college found that females exhibited more SRL strategies and academically outperformed males (Ray, Garavalia, & Gredler, 2003).

Literature examining SRL strategies by ethnicity is almost nonexistent. In regards to the topic, literature links academic performance to ethnicity difference, suggesting in general, Caucasian students academically outperform African American and Hispanic students (Riegle-Crumb & Grodsky, 2010). One study examining SRL strategies by ethnicity found differences, although the results were not statistically significant. Caucasian males course grades and minority female grades were related to intrinsic and extrinsic motivation. Minority males and Caucasian female course grades were related to task value and self-efficacy (Bembenutty, 2007). This study will be one of few which examine SRL strategies by gender, ethnicity and age.

Problem and Significance

Although developmental education has shown to be beneficial to students who complete the coursework, there are still a number of students who withdraw or dropout of developmental education courses, never being able to attain their goals. The number of students not successfully completing developmental math courses continues to be a national problem (Bahr, 2008). Developmental students are at risk for not attaining their academic goals, perhaps because of the lack of self-regulation strategies, motivation or personal issues. These students, although underprepared, may benefit from self-regulation

strategies in the classroom. Understanding whether self-regulation affects the learning process of these students may be critical to solving the problem of underprepared students withdrawing and dropping out of math courses. Past studies have shown that students who pass developmental math courses are just as likely to attain their academic goals as those who did not have to take developmental math (Bahr 2008; Bettinger and Long, 2009). Furthermore, according to Bembenutty (2010), regulated learning helps students successfully pass challenging courses, especially math courses.

The study of self-regulated learning strategies on math achievement and metacognition of students enrolled in a developmental math course is important to the field of education because it investigates an area that is highly debated in the community college system (developmental math courses) and explores an area of research that has not been thoroughly investigated. Studies that examine the impact of SRL strategies with community college students and especially the underprepared community college student are dearth in the literature. Most self-regulated learning studies investigate K-12 students or college students attending four-year institutions of higher learning. Furthermore, very few studies investigate the impact of SRL strategies by gender, ethnicity and age, especially with community college students. Last, SRL intervention training using a survey system, such as SurveyMonkey®, with a face-to-face class is nonexistent in the literature. Investigating self-regulated learning among community college students may assist with further understanding the underprepared student's lack of motivation and inability to successfully navigate the developmental math course sequence.

The results of this study have implications for community college instructional policy. Clarity of the impact self-regulated learning has on community college students

can lead to a change in how developmental courses are offered, by possibly embedding self-regulated learning in the curriculum. As the number of students attending community college increases – along with the number of students needing developmental education – it is imperative for colleges to ensure the way they offer developmental education is beneficial to the student, does not waste money, and ultimately allows students to attain their academic goals. Thus, the study will offer college administrators and teachers strategies to assist unmotivated, underprepared students who are likely to drop out of a developmental math course. This is important since the literature suggests that underprepared students have lower levels of practicing SRL strategies than other students (Bol & Garner, 2011; Ley & Young, 1998). The students will also have techniques at their disposal that, when applied, can help in other courses and lead to higher retention and graduation rates.

Purpose and Research Questions

The purpose of this experimental study was to investigate the impact training of self-regulated learning has on math achievement and metacognition of community college students enrolled in developmental math courses. Furthermore, the study investigated if the impact of training of self-regulated learning on math achievement differs based on gender, age and ethnicity.

1. Will the effect of training in self-regulated learning on math achievement vary by gender?
2. Will the effect of training in self-regulated learning on math achievement vary by ethnicity?
3. Will the effect of training in self-regulated learning on math achievement vary by age?
4. Will the effect of training in self-regulated learning on metacognition vary by gender?

5. Will the effect of training in self-regulated learning on metacognition vary by ethnicity?
6. Will the effect of training in self-regulated learning on metacognition vary by age?
7. How does training in self-regulated learning effect math achievement of community college students enrolled in a developmental math course?
8. How does training in self-regulated learning effect metacognition of community college students enrolled in a developmental math course?

Methodology

This true experiment was conducted at a community college in the state of Virginia. The study included participants in developmental math courses at one of the four campuses of the community college. Participants in each class were bifurcated and randomly assigned so that one group received the treatment of training in self-regulated learning and one group did not receive the training. There were a total of 116 students participating in the study. At the end of the math unit students were administered the Motivated Strategies for Learning Questionnaire (MSLQ) to measure metacognition and a final math exam to measure math achievement. Multiple regression was performed to determine the relationship between self-regulated learning and each of the two dependent variables–math achievement and metacognition.

Limitations

There were limitations to this study. First, the participants in the study included students who were enrolled in developmental math courses at one community college. The rationale for this was the accessibility of data and need for control in this experiment. Second, the study included only teachers who taught at the community college, most of whom were adjuncts. Third, the study included only developmental math classrooms that matched the criteria for the study. Fourth, the study included only teachers who

volunteered their classrooms for the study. Fifth, the study used a self-reported instrument, the MSLQ. As with any self-reported instrument, social desirability and accuracy affect validity. Lastly, attrition may have impacted validity since data collection took place over two four-week terms.

Assumptions

There are a few assumptions of this study. First, all teachers participating in this study were qualified to teach developmental math to community college students. Second, the student population studied is a representative sample of the total population of community college students who took developmental math at the community college in this study. Last, students were placed in the correct math unit based on the accurate evaluation of their placement test scores.

Summary

Chapter 1 summarizes the challenges associated with math achievement in the United States and how math achievement gaps impact underprepared learners wanting to be successful in college. In addition, self-regulated learning is defined and Zimmerman's (2002) model is presented as a framework for this particular study. This framework is used to research the relationship between self-regulated learning, math achievement and metacognition levels of community college students. A literature review of math achievement, self-regulated learning and three demographic variables (gender, age and ethnicity) relating to the two aforementioned areas are presented in Chapter 2. Subsequent chapters present the methodology, results and discussion of the findings.

CHAPTER 2

LITERATURE REVIEW

The chapter presents a brief overview of math achievement in the United States, followed by discussion of the effect of the achievement gap on students pursuing a higher education and math achievement in college students. Next, developmental education and its effectiveness are addressed, including specific statistical information regarding Virginia Community Colleges developmental students. Self-regulated learning is presented in the latter part of the chapter with empirical evidence of its impact on academic outcomes. Finally, self-regulated interventions are described with empirical evidence of their effectiveness.

Math Achievement in the United States

Mathematics literacy is a focal point for the United States of America in their efforts to remain competitive in a global economy. The level of math achievement is an important topic for industrialized countries around the world (Geary, 2000). As global competition increases for leaders in science, technology and math, the United States of America strives to create policies and programs to catapult the country to the forefront of these developments. Institutions of learning are being held educationally accountable. Although policies such as the *No Child Left Behind Act* and *Achieving the Dream* strive to increase math competence in students while narrowing the achievement gaps, there still remains a large portion of students entering college underprepared and lacking the necessary math skills needed to attain their academic and career goals (Lee, 2012). Students need strong math skills to not only advance through the college curriculum, but

"strong mathematical abilities are critical for success in many facets of life, including employability and wages" (Maloney, Waechter, Risko, Fugelsang, 2012, p. 380).

Recognizing the importance of assessing math competencies both nationally and internationally, the United States primarily uses three assessment instruments (one national and two international) to assess student math levels at different stages in their development (Kerachsky, 2008). The National Assessment of Educational Progress (NAEP), the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) each offer a comprehensive analysis of American students' math competencies (Kerachsky, 2008). The three assessments are different in that the NAEP assesses what students know in core academic areas in the 4th, 8th and 12th grades, to include mathematics; the PISA measures math literacy of 15 year-olds by country; and the TIMSS measures content and cognitive domains in math and science for 4th and 8th graders by country (Kerachsky, 2008).

The most recent data from these assessments suggested that the United States is still lagging behind other countries in math competency. According to the 2009 PISA, the United States ranked 25th (not a measurable difference between Ireland and Portugal) among the 34 Organizations of Economic Co-operation and Development (OECD) participating in the assessment (National Center for Education and Statistics, 2009). The 2007 TIMSS results indicated that the Unites States 8th graders (with an average score of 508) were outperformed by five countries – Chinese Taipei, Republic of Korea, Singapore, Hong Kong SAR and Japan with no measurable difference from five other countries – Hungary, England, Russian Federation, Lithuania, and Czech Republic (National Center for Education Statistics, 2009).

The 2011 NAEP in mathematics assessed data nationally. In general, there was minimal improvement from 2010 to 2011 with Virginia being one of the states whose students' math achievement levels were above the public national average. The 2011 national average for 4th and 8th graders was 240 and 283 and Virginia students scored 245 and 289 (National Center for Education Statistics, 2011).

Although the data from these assessments should not be directly compared since each instrument measures different competencies within different populations ("Comparing NCES," n. d.), it can provide a benchmark for how American students rank nationally and internationally.

In an effort to rectify American's lagging behind other countries in math and science competencies, President Obama encouraged every American to attain at least one year of college education so that America could retain its status as the most educated nation (Lee, 2012). Some researchers thought the request for more Americans to become educated would lead to an increase in underprepared students attending college (Lee, 2012); indeed this was the case.

Math Achievement Gap

Achievement gaps occur when one group of students, usually identified by ethnicity or gender, significantly outperforms another group based on average test scores (Carpenter, Ramirez, & Severn, 2006). There is a large body of research focusing on gender and ethnic achievement gaps across disciplines, districts and states (Ellison & Swanson, 2010; Fryer & Levitt, 2006; Lee, 2012). Although researchers have opposing views as to when math achievement gaps begin, the size of the gap, and the causes of the

gap, the common ground expressed through the literature is that there are gender and ethnicity gaps in math achievement.

Math achievement gap and gender differences. Literature supports gender differences in mathematics achievement in favor of males (Carrell, Page, & West, 2010). Some researchers suggested that gender math achievement gaps occur as early as kindergarten (Penner & Paret, 2008; Robinson & Lubienski, 2011) and become more pronounced at the end of middle school and beginning of high school with females starting to fall behind males (Hyde, Fennema, & Lamon, 1990). Hyde et al. (1990) posited the math achievement gap widens in high school, which supports the study by Riegle-Crumb and Grodsky (2010) indicating that the gap is more pronounced in the upper level of the distribution, such that the higher level math courses have a greater disparity between math achievement of males and females. The gender gap continues in college with males outperforming females, especially in the higher level math courses (Carrell, Page, & West, 2010; "Gender gaps," 2009).

Math achievement gap and ethnicity differences. The math achievement gap leaves more minority students at a disadvantage when entering college. These racial math achievement gaps threaten students' adequate preparation to attend at least a two-year college. Researchers found ethnic differences in math achievement start as early as kindergarten, persist through middle school and eventually reveals itself in college. This is especially true in community colleges where a greater proportion of minority students are enrolled in developmental courses (Lee, 2012).

The NAEP results showed the ethnic disparities in math achievement amongst 8^{th} graders in the U.S. and the state of Virginia. The national public average score on the

assessment was 283, with White students scoring 293, Black students 262, and Hispanic students 269. There is a 31 point difference between White and Black students and a 24 point difference between White and Hispanic students. The state scores revealed the same disparity with the 8th grade Virginia average score of 289, White (297), Black (268), and Hispanic (279) – a 29 point difference between Whites and Blacks (Table 2.1) and an 18 point difference between White and Hispanics (Table 2.2).

Table 2.1

2011 NAEP Results for White – Black Comparison

	All	White	Black	Difference
National public				
4th graders	240	249	224	25
8th graders	283	293	262	31
Virginia				
4th graders	245	251	229	22
8th graders	289	297	268	29

Table 2.2

2011 NAEP Results for White – Hispanic Comparison

	All	White	Hispanic	Difference
National public				
4th graders	240	249	229	20
8th graders	283	293	269	23
Virginia				
4th graders	245	251	237	14
8th graders	289	297	279	18

Math achievement gap in community colleges. The gender and ethnicity disparities in math achievement follow students into the community college. The 2007 fall Cohort data from the Virginia Community College System (VCCS) confirmed the existence of achievement gaps between ethnicities and genders and age groups. Eight

percent of African Americans, 17% of Caucasians and 17% of other students were college ready, with 44% of African American students needing both developmental math and English courses compared to 22% of Caucasian and 27% of other students. Thirteen percent of females were college ready compared to 17 % of males. Sixteen percent of 22 or younger students were college ready compared to 9% of students between 23 and 45 and 7% of students older than 45. Overall, 45% of Caucasians, 63% of African Americans and 48% of others need a developmental course when they enter a community college in the state of Virginia (Virginia Community College Systems, 2012).

The ongoing disparity with math achievement in relation to gender and ethnicity indicates that additional research needs to be conducted on narrowing the gap. In several studies, self-regulated learning techniques increased math achievement outcomes because students were taught how to adjust their learning to be successful (Kramarski & Gutman, 2006; Perels, Dignath & Schmitz, 2009). Implementing these strategies within college courses, especially math courses, may assist students, minorities and women in particular with higher levels of math competence. A community college in California with a large Latino population (52%) and first generation college student population (82%) created the Mathematics, Engineering, Science and Achievement (MESA) program to provide students with tutorial and supplemental instruction to increase access and completions of higher level math and science courses (Kane, Beals, Valeau, & Johnson, 2004). There was an increase in the number of students enrolling in trigonometry, pre-calculus and physics courses as well as an increase in students declaring math and engineering as a major (Kane et al., 2004).

Math achievement and college students. Although a study conducted by Stebleton and Soria (2012) found that two of several barriers for first generation college students at a research university are deficient math skills and inadequate study skills, very little research exists regarding students enrolled in developmental education courses at four-year institutions. These statistics and comparisons are often cited in studies which focus on community college students and developmental education (Moore, Jensen, & Hatch 2002; Wathington et al., 2011). Data reveals there are an increasing number of students graduating from high school who are not prepared for college level mathematics and most often these students attend a community college (Bettinger & Long, 2009). This pattern is not a new phenomenon; many researchers can trace math achievement issues back to kindergarten. Speybroeck et al. (2012) found that teacher expectations of kindergarten students predicted their future math achievement, which coincides with Beilock, Gunderson, Ramirez and Levine's (2010) study of female kindergarteners who, by the end of a class, had higher levels of math anxiety and lower self confidence in their math abilities. The suggestion that the math achievement gap starts early and follows students straight to college is an indicator of the pervasiveness and persistence of math achievement difference in the United States.

Sixty-percent of students entering a community college need at least one developmental course (Le, Rogers, & Santos, 2011). Some researchers suggested these students are not as likely to attain their academic goals as other students (Bailey, Jeong, & Cho, 2010). However, other researchers indicated that students who are successful in developmental math courses are just as likely to attain their academic goals as those who were not required to enroll in a developmental math course (Bettinger & Long, 2009;

Bahr 2008). Bahr (2012) actually investigated the strata of students in developmental courses and suggested students at the lower end of the developmental math sequence are less likely to attain their academic goals compared to those at the higher end of the math sequence. Thus, students who enter college with extreme deficiencies in mathematics suffer differential attrition.

Le, Rogers and Santos (2011) proposed students are more likely to fail a developmental math course than any other course in higher education. Typically, students lack the necessary study skills to be successful in these courses (Fike & Fike, 2008). Isaacon and Fujita (2006) suggested that students who move from high school to college do not necessarily understand the higher level of thinking necessary to be successful. College level courses require a deeper level of thinking beyond memorization and a higher level of critical thinking skills. As a result, students who do not know how to adjust their learning strategies to fit the new challenges associated with college level courses do not fare well. Equipping students with skills (self-regulated learning) that will help them successfully navigate learning in their classes can assist the underprepared student with connecting to the academic environment and ultimately attaining their academic goals.

Math achievement, self-efficacy and math anxiety. There are several non-cognitive factors which can influence math achievement. These factors, although relevant, are not the basis of this study. Some general information is included about math anxiety and self-efficacy in an effort to present a broader understanding of math achievement and how it might provide indirect contextual information for understanding the variable under study.

In kindergarten (Speybroeck et al., 2012), middle school (Hines & Kritsonis, 2011) and high school (Ozgen & Bindaka, 2011), noncognitive predictors such as self-efficacy (Fast et al., 2010) and math anxiety (Roth, 2002) impact math achievement. Self-efficacy refers to a person's belief about being able to complete a task (Schunk, 1996). Several researchers have demonstrated the positive relationship between high self-efficacy and academic performance across subjects and disciplines (House, 1993; Mattern & Shaw, 2010; Weiser & Riggio, 2010). In addition, the extensive body of literature on self-efficacy supports the positive relationship between academic self-efficacy and college performance, perceived range of major options, and college persistence (Gore, 2006).

Researchers investigating the relationship between math self-efficacy and math achievement found results which are supported by previous studies identifying the positive relationship between self-efficacy and academic performance. Fast et al. (2010) found higher levels of math self-efficacy positively predicted math performance in elementary students. The study of math self-efficacy in college students also suggested that math efficacy impacts student performance in math and in the selected major. Wang (2012) found math efficacy affects a student's choice to major in STEM fields. Another study found a significant relationship between self-efficacy to learn mathematics asynchronously (SELMA) and math performance (Hodges, 2008).

Some researchers postulated that the math achievement gap exists between genders because of math anxiety (Ashcraft & Moore, 2009). Beilock, Gunderson, Ramierz and Levine (2010) found female teachers' anxiety impacted the level of math anxiety girls experienced, eventually leading the girls to believe that math was for boys

and not them. Roth (2002) found that the attitude of the teacher impacted the math anxiety level of the student. Implementing strategies which increase self-efficacy or reduce math anxiety may impact math achievement. Hanlon and Schneider (1999) implemented a pilot self-efficacy training program for 17 pre first-year college students during the summer prior to entering college. The cohort of students, identified goals, maintained self-monitoring forms and compared their self-judgments about daily math quizzes to their math test score. These strategies are considered to be an important component of SRL (Zimmerman, 2002). Students who participated in the training program outperformed students who were enrolled in a remedial math class during the same time.

Developmental Education

Developmental education is described as a series of courses offered in sequential order to assist students who have deficiencies in math, English or writing prior to enrolling in a college or university (Davis & Palmer, 2010). The courses are designed to teach students the skill sets deemed necessary to excel in a college environment. Students are required to take these courses when they do not score in a specified range on a designated college placement test that would exempt them from such coursework or if they do not meet the institution's exemption criteria prior to enrolling at the college or university. Although developmental education is not a new phenomenon, it is one that has generated much debate over the last 20 years (Davis & Palmer, 2010).

Effectiveness of developmental education. Some researchers suggest that developmental education is effective (Bettinger & Long, 2009), allowing students who would otherwise not have the opportunity to attend college attain their academic goals.

However, there are others who contend that developmental education programs waste taxpayer money (Bahr, 2008) and do not assist the underprepared student in attaining academic goals (Adelman, 2004; Bailey, Jeong, & Cho, 2010; Calcagno & Long, 2008). Some of the controversy is present because of the definition of retention and effectiveness. Some researchers define effectiveness as students attaining their academic goals (Bettinger & Long, 2009), while others define effectiveness as successfully completing the college level math or English course needed to advance in their program of study (Illich, Hagan, & McCallister, 2004). Other researchers have defined effectiveness as retention, which is either retaining a student from one semester to another or retaining a student from one year to another (Fike & Fike, 2008).

Opponents of developmental education include Calcagno and Long (2008), who conducted a study in Florida using a dataset of approximately 100,000 students, found that students assigned to remediation are persistent through the second year of school, but remediation does not increase the completion of degree attainment or college-level credits. The study suggested that developmental education is not effective for impacting the long range goals of students wanting to attain a degree.

However, there are other researchers who suggested developmental programs increase the likelihood that a student will attain their academic goals (Bahr 2008; Bettinger & Long 2009). Research conducted by Bettinger and Long (2009) and Attewell, Lavin, Domina, and Levey (2006) were longitudinal, comprehensive and included multiple institutions. Bettinger and Long (2009) conducted a study analyzing data from the Ohio Board of Regents. Participants were 28,000 traditional-aged, college undergraduates matriculating to an Ohio public university for the first time in the fall of

1998. The researchers analyzed data over a six year period to determine the impact remedial education has on college performance and persistence. Bettinger and Long (2009) found developmental education has a positive effect on academic outcomes. Students who participated in developmental education were just as likely to attain their academic goals as students who did not participate in developmental education. They also discovered that math remediation increases the likelihood that a student who has an interest in math or a math-related field will attain a degree. Attewell et al. (2006) conducted a longitudinal study known as the National Educational Longitudinal Study (NELS: 88) which followed a representative sample of the nation's 8^{th} grade class of 1988, scheduled to graduate high school in 1992. They found that 50% of African American students and 34% of Hispanic students who graduated from a bachelor degree program, graduated after taking remedial coursework.

Other studies examined student success in developmental math courses. According to Waycaster (2001), students who took a developmental math course did just as well, if not better, in college algebra as students who placed directly into the course. Bahr (2008) came to the same conclusion in his study, finding that community college students across 107 community colleges who were successful in math remediation courses were just as likely to attain credentials or transfer to a four-year school as compared to students who did not need remediation. The researchers suggest that math remediation helps the underprepared student attain academic goals.

Although there are opponents and supporters of the effectiveness of developmental education, there remains one disturbing fact that is true across studies. Many students who enroll in developmental education courses never complete it because

they drop out, fail or withdraw (Bahr, 2008). Bahr (2008) found that three out of four students in the study did not successfully remediate, indicating that they never completed the developmental math course. Additional studies suggest that withdrawal rates from math developmental courses remain high among community college students who need the course to complete their degree (Edgecombe, 2011; Zavarella & Ignash, 2009). Adelman (2004) supported these findings in his study reporting that developmental math courses not only had the highest withdrawal rate of all college courses (21-29%), but also the highest failure rate at 14%. Exploring factors or learning strategies that make students successful in developmental math courses can assist with understanding the underprepared student.

Researchers found Virginia's developmental education program to be effective in terms of retention. Students in the fall 2007 Cohort, who were enrolled in a developmental course at a VCCS institution, had higher persistent rates from fall to spring (80%) and fall to fall (59%) than students who took only a college-level course, 70% and 52% respectively. The data suggests that students who successfully complete a developmental course persist at a higher rate than students who do not take a developmental course (Virginia Community College Systems, 2012).

Developmental education in the Virginia community college system. Developmental education is offered as a remedy to students who enter through college doors unprepared for college level work. In the past, developmental education caused more barriers for students than intended, with some taking longer to graduate because of developmental course work, others running out of financial aid, and still others dropping out because of the added time to attain their goals (Bettinger & Long, 2009). Virginia

decided to offer a solution to students needing developmental education by redesigning the program. The redesign was an effort to reduce the need for developmental education, decrease the time needed to complete developmental education by students, and to increase the number of developmental students graduating or transferring in a four year time frame from 1-in-4 to 1-in-3 (Virginia Community College Systems, 2012).

The rate of students placing into developmental math courses continues to increase (Virginia Community College Systems, 2012). The fall 2007 Cohort of students attending a community college in the state of Virginia were recommended for developmental math education (57%), developmental reading (21%) and writing (31%). Seventy-eight percent of students took the placement test. Of those, only 21% of all students taking the placement test were college ready in mathematics in 2007. Of the students taking a developmental math course, 48% were successful in completing the course the first time in 2007. More than half of the students did not complete a developmental course on their first attempt. However, approximately 31% of the students who were not successful in passing the course the first time attempted the course a second time. Of these students, 34% passed. The need for strategies to assist students with passing developmental math courses is essential in ensuring they only have to take it one time, if at all. "Given that most incoming students are placed into developmental mathematics, English, or both, it is imperative that developmental instruction is delivered in a manner that gives students the necessary skills to succeed in college in as short a period of time as possible" (Virginia Community College Systems, 2012, p. 4.)

Self-Regulated Learning

> Self-regulation is not a mental ability or an academic performance skill; rather it is the self-directive process by which learners transform their mental abilities into

> academic skills. Learning is viewed as an activity that students do for themselves in a proactive way rather than as a covert event that happens to them in reaction to teaching.
>
> —Barry J. Zimmerman, "Becoming a Self-Regulated Learner"

Proficient self-regulated learners believe the learning process can be controlled (Isaacson and Fujita, 2006). They are aware of their strengths and weaknesses as learners and make personal adjustments to their learning so they are able to achieve desired outcomes (Isaacson and Fujita, 2006). The self-evaluative process they use helps adjust their learning based on discrepancies between desired and actual outcomes (Travers, Sheckley, & Bell, 2003). Furthermore, as proactive learners aware of their learning capabilities they acknowledge the skills they possess or do not possess (Zimmerman, 1990). "When they encounter obstacles such as poor study conditions, confusing teachers, or abstruse text books, they find a way to succeed" (Zimmerman, 1990, p. 4). Students are self-regulated learners to the degree that they exercise cognitive, metacognitive and motivational components interactively in their learning process (Throndsen, 2011).

Zimmerman's (2002) cyclical model of self-regulated learning describes the three phases of the self-regulated learning process: (a) forethought; (b) performance or volitional control; and (c) self-reflection (Figure 2.1) (Table 2.3), which incorporates a feedback loop so that the learner can revaluate goals throughout the process. The forethought phase includes setting goals, selection of strategies and assessing self-efficacy. During this phase, the learner will identify their goals and plans for achieving them. The performance or volitional control phase includes attention focusing, self-instruction and self-monitoring of progress. During this phase, the learner attempts to

learn tasks and execute a plan for excluding distractions. In addition, learners monitor their progression by being aware of conditions which may or may not contribute to a successful outcome. The self-reflection phase includes self-evaluation of set goals and adaption. Learners self-evaluate their performance against the goal or standard that was set and react to their success or failure of meeting the goal(s) (Isaacson & Fujita, 2006). Bol and Garner (2011) suggested that Zimmerman's model implies that all students have self-regulatory capacities, but the degree of use may differ between students.

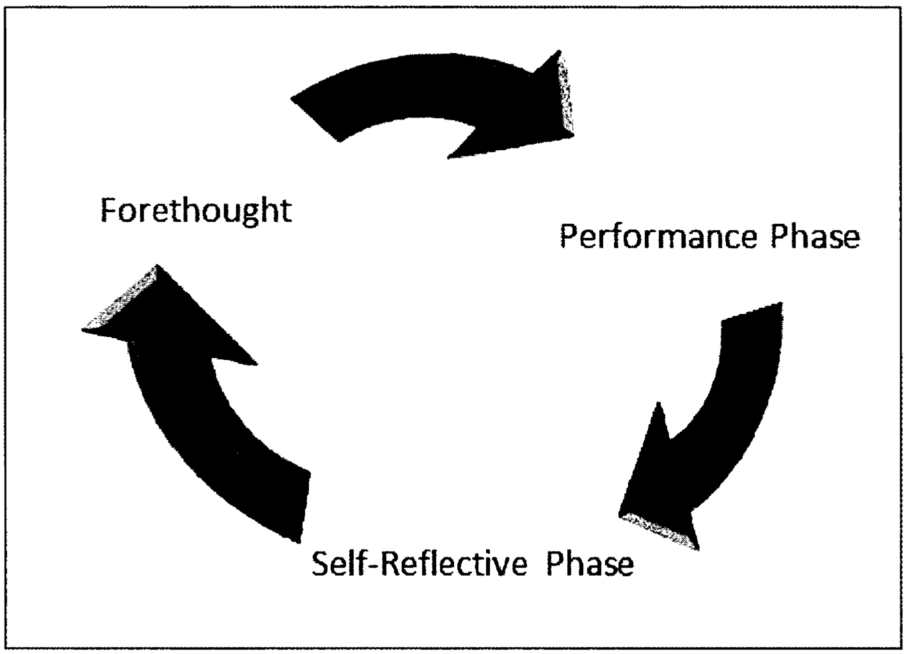

Figure 2.1. Cyclical model of self-regulation based on Zimmerman (2002).

Characteristics of self-regulated learners. Adept, self-regulated learners use effective learning strategies in and outside of the classroom (Lewis & Litchfield, 2011). Zimmerman (1995) suggested that self-regulated learners do not have a fear of failure

Table 2.3

Three Phases of Self-Regulated Learning and Tasks

Phase	Components	Tasks
Forethought	Goal setting Strategic planning Assessing self-efficacy Selection of strategies and methods	Students identify their goals and a plan for accomplishing their goal.
Performance (volitional control)	Attention focusing Excluding distractions Self-instruction Self-monitoring	Students learn tasks and monitor what they are in relation to their goals. Students identify distractions and strategies for overcoming these distractions.
Self-reflection	Compare self-monitored information against the set goal Self-reaction and adaptation	Students assess their success or failure at meeting the goal and make adjustments accordingly.

and willingly admit when they do not understand a problem. Self-regulated learners adjust strategies, resources and effort based on the goals being pursued and desired outcome (Pintrich, 1999). Self-regulated learners are active in their learning process. They use various learning techniques and strategies to monitor their learning and adjust their goals (Schloemer & Brenan, 2006). High level self-regulators are able to accurately assess how well or poorly they did on a test, while lower level self-regulators are not able to estimate their success on a test (Isaacson & Fujita, 2006). As noted, the accuracy of these types of metacognitive judgments is termed calibration and is one type of self-monitoring and reflection (Bol & Hacker, 2012).

Self-regulated learning and academic outcomes. Studies have indicated there is a significant relationship between the use of self-regulation strategies and academic outcomes (Bail, Zhang, & Tachiyama, 2008; Barnard-Brak, Lan, & Paton, 2010; Dignath & Buttner, 2008); although, few of these studies are conducted with community college

students or underprepared students. Barnard-Brak, Lan, and Paton (2010) found that students who use self-regulation strategies in their learning have more positive academic outcomes than individuals who do not exhibit self-regulated learning behaviors.

Studies at community colleges which examine the impact of self-regulated learning on a specific community college population include a study by Ray, Garavalia and Gredler (2003) which examined gender differences in 286 community college students enrolled in developmental courses. They found females reported greater use of self-regulated learning strategies and had greater achievement levels in developmental courses. Yost (2003) examined the relationship of motivational orientation (defined as value, expectance and test anxiety) and self-regulation on the academic performance of nursing students attending a community college. Results suggested that students who had higher levels of test anxiety had lower performance, and students with a positive motivational orientation used more cognitive and metacognitive skills.

Helping students understand how to self-regulate their learning can be beneficial to their overall academic achievement and degree attainment of students attending a community college.

According to Pintrich (1999), self-regulated learning can be taught. Studies indicated that when students are taught self-regulation strategies, they can learn to overcome their weaknesses and be successful learners. Montalvo and Torres (2004) suggested adequate training in self-regulated learning can improve student performance in the classroom and the degree of control over learning. Bail, Zhang, and Tachiyam (2008) found that a single self-regulated learning course can have a significant effect on the graduation rates and academic outcomes of a group of underprepared students. The

study suggested that teaching students how to regulate their learning can assist them with understanding how to learn so they are empowered to attain their academic goals.

If students are not taught how to use self-regulated strategies, they may continue to be poor predictors of their learning, which may lead to repeated failure in courses (Bol & Garner, 2011). Underprepared students in particular may not be good predictors of how they perform. A study conducted by Isaacson and Fujita (2006) found that high achieving undergraduate college students more accurately predicted their test results and goal setting as compared to lower achieving students. Students who can accurately identify their lack of understanding of course material can redirect their learning by incorporating self-regulated learning techniques to be more successful in a course (Bol & Garner, 2011).

Self-regulated learning and math achievement. Zimmerman's (2002) theoretical perspective suggests that students' perceptions of themselves as learners (self-efficacy) and their ability to self-regulate are key components necessary for academic achievement. Self-regulated learning offers students techniques for comprehending challenging course material. In general, when students are given instruction on how to learn, they are often able to improve their academic performance.

One way in which students may improve their academic performance in math is through the use of self-regulated learning. Literature links self-regulated learning to improved math achievement (Kramarski & Gutman, 2006; Kramarski & Mevarech, 2003; Kramarski, Weisse, & Kololshi-Minsker, 2010; Perels, Dignath & Schmitz, 2009). Kramarski and Gutman (2006) conducted a study with 65 ninth graders in which one class was exposed to self-regulated learning strategies and the other class was not. The

class receiving three aspects of self-regulated learning (self-metacognitive questioning, mathematical explanations and metacognitive feedback) outperformed students who did not receive the SRL instruction.

Perels, Dignath and Schmitz (2009) confirmed the findings of Kramarski and Gutman (2006) when they demonstrated self-regulated learning is effective in improving math achievement. Unlike the Kramarski and Gutman (2006) study which used two different teachers, this study used one teacher for both the treatment and control group. The researchers conducted a quasi-experimental study with 53 German 6th graders in which self-regulated training was embedded into a math class. The teacher taught mathematical concepts as usual to one 6th grade class and incorporated self-regulated learning training in the other class. The results revealed that self-regulation strategies can improve mathematical achievement.

Throndsen (2011) suggested that training in self-regulated learning should include cognitive, metacognitive and motivational aspects of self-regulation, especially for low performing students. Low performing students often lack motivation and, regardless of appropriate self-regulation strategies, may still not perform well because of intrinsic and extrinsic motivation issues. He conducted a longitudinal study which examined the self-regulated learning of basic arithmetic skills in 27 six and seven year olds while incorporating self-regulated strategies into their process. Low performing students relied on counting techniques while higher performing students relied on retrieval to answer questions. He concluded that metacognition plays a vital role in students understanding math and their overall performance.

In general, metacognition is the ability of a learner to control his or her learning process. One metacognitive skill reflected in literature is calibration, which refers to the degree in which a person's judgment about their academic capabilities is accurate (Bol & Hacker, 2012; Labuhn, Zimmerman, & Hasselhorn, 2010). Kramarski and Mevarech (2003) examined the impact of metacognitive training on students' mathematical reasoning. They discovered students receiving metacognitive training significantly outperformed students who did not receive the training. In addition, the study suggests that metacognitive training coupled with cooperative learning may increase math achievement in students.

Although not specific to math achievement, Bol, Hacker, Walck, and Nunnery (2012) found similar results to Kramarski and Mevarech (2003). They found using calibration with guidelines in group settings increased students' accuracy in predicting pre and post test scores. The quasi-experimental study was conducted with 82 high school biology students. Four biology classes were assigned to one of four treatment groups: group setting/guidelines for calibration, groups setting/no guidelines for calibration, individual setting/guidelines for calibration and individual setting/no guidelines for calibration. Students in the group setting with guidelines had the greatest accuracy in predicting test scores before and after the exam. Students understanding of their math abilities and performance may assist with an increase in math achievement, especially in lower performing students such as the underprepared. These studies suggest the importance of introducing students to self-regulated learning strategies in an effort to improve math performance. The SRL strategies may include some strategies listed in the

aforementioned research, but is not limited to, feedback, metacognitive training, calibration, group settings and self-metacognitive questioning.

Self-regulated learning and underprepared students. Research involving self-regulated learning strategies and the underprepared student is scarce; there is more research directed toward self-regulated learning and the community college student. For those researchers who explored SRL strategies and the underprepared students, they found that SRL interventions have both short term and long term effects in improving academic performance of underprepared students. Williams and Hellman (1998) found significant correlations between SRL behaviors and GPA of first generation community college students. Bail, Zhang and Tachiyama (2008) investigated the effects of a self-regulated learning course on long-term student academic outcomes. Students who took the self-regulated learning course had significantly higher academic outcomes (GPA) four semesters later and were more likely to graduate than students who did not take the self-regulated learning course. In another study, Ley and Young (1998) examined the difference between SRL behaviors in underprepared students, those placing into developmental courses, and regular admission students. They reported that underprepared students had a lower level of practicing SRL behaviors, which may attribute to their current status as an underprepared student.

The linkage between self-regulated learning strategies and underprepared students in development math courses is worth investigating, given that underprepared students need to complete the developmental math sequence before moving forward in their program plan of choice. Jones and Byrnes (2006) suggested that self-regulated learning is

a strategy that may assist students who are likely to withdraw from a course for personal reasons, lack of motivation or low self-efficacy.

Self-regulated learning and demographic variables. ***Age.*** Adult learners for this study are defined as between the age of 25-50 and the traditional college students are between the ages of 18-23, which is consistent with the literature comparing the two groups (Butler & Markley, 1993; Kenner & Weinerman, 2011). Malcolm Knowles' Andragogy Theory describes the adult learner as being independent and self-directed, having a depth of experiences, ready to learn and actively engaged in the learning process, task oriented and intrinsically motivated (Baskas, 2011; Kenner & Weinerman, 2011). In general, the adult learner is more goal oriented and task focused than the traditional college student (Kenner & Weinerman, 2011).

Literature links adult learners to higher academic achievement, higher levels of intrinsic motivation, and higher levels of goal orientation than traditional college students (Bye, Pushkar, & Conway, 2007; Hoyert & O'Dell, 2009; Jacobson & Harris, 2008; Kenner & Weinerman, 2011). One study, conducted by Jacobson and Harris (2008), investigated the self-regulated learning measured by the MSLQ. Participants in the study were college students who attended a four-year college that primarily served traditional students and a four-year college that primarily served nontraditional students. Students 18-22 were classified as traditional and 23 and above were classified as nontraditional. The results indicated a significant difference between traditional and nontraditional students on two of the motivational subscales of the MSLQ (intrinsic goal orientation and task anxiety) and three of the strategies for learning subscales (elaboration, critical

thinking and metacognitive self-regulation) with nontraditional students having higher levels than traditional students.

Another study linked adult learners to higher levels of metacognition compared to younger learners. Vukman (2012) conducted a study involving 282 participants from four different age groups ranging from 13-45. The researcher investigated the accuracy in which participants could self-evaluate their performance. The participants solved tasks addressed to spatial, verbal-propositional and social reasoning, and evaluated their own performance on these tasks. The researcher found the accuracy of self-evaluation increased with age, such that the older the learner the more accurate their self-evaluation of their learning. In addition, males were slightly more accurate than females. The findings suggested that older learners are more reflective and use metacognition with more accuracy than younger learners. Linder and Harris (1992) also found the ability of a learner to self-regulate increases with age.

Gender. The literature on gender differences in self-regulated learning strategies is substantial, although few studies are specific to college students. The literature suggested in general, females use self-regulated learning strategies more than males (Bezzina, 2010; Ray, Garavalia, & Gredler, 2003; Zimmerman & Martinez-Pons, 1990). However, studies reported on various components of self-regulated learning to include, but not limited to task value, self-efficacy, goal orientation, control of learning beliefs, help seeking and peer learning.

In a study conducted by Bezzina (2010), 11^{th} grade females were also found to use SRL strategies more than males. However, males reported to be intrinsically motivated and have higher self-efficacy. In addition, females and males did not report a

difference on test anxiety, where other studies reported females have higher levels of test anxiety (Ashcraft & Moore, 2009; Roth 2002) which may contribute to the difference in math achievement between males and females.

In studies specific to college students, Lynch and Trujillo (2011) reported similar results submitting males' academic performance in an Organic Chemistry course was associated with intrinsic motivation. Also, males reported higher levels of value of task, self-efficacy, and sense of control over learning than females. Virtanen and Nevgi (2010) found undergraduate females attending a Finnish University scored higher than males on help-seeking strategies, utility value and performance anxiety, which suggest that gender differences associated with self-regulated learning are not specific to American students. However, Bidjerano (2005) found that there was not a significant gender difference with help seeking strategies and critical thinking skills.

Ray, Garavalia, and Gredler (2003) conducted a study specific to developmental students enrolled at a community college. Using 286 participants, the researchers examined gender and aptitude in relation to task value, SRL strategies and academic performance. They found gender differences existed among developmental students when using self-regulated learning strategies, with females using more SRL strategies than males and reporting higher levels of academic achievement.

Ethnicity. Research investigating ethnic differences in self-regulated learning is dearth. Several studies investigated the role of ethnicity separately from self-regulated learning with self-regulated learning being compared to academic outcomes (Barnard-Brak, Lan, & Paton, 2010), math achievement (Perels, Dignath , & Schmitz, 2009) and self-efficacy (Siegle & McCoach, 2007). However, the examination of the relationship

between ethnicity and self-regulated learning is almost absent from the literature. Literature does link ethnicity difference to achievement, suggesting that Caucasian students generally outperform African American (Bembenutty, 2007) and Hispanic students (Riegle-Crumb & Grodsky, 2010). Studies attribute several reasons for disparity in academic performance to include, but not limited to, difference in socioeconomic background, school systems, quality of teachers and cognitive abilities (Cooper & Schleser, 2006; Riegle-Crumb & Grodsky, 2010). The disparity, starting early in the educational process of students, may impact their overall success once they enroll in college.

Bembenutty (2007) conducted a study that examined the relationship between ethnic and gender differences in relation to academic performance, delayed gratification, self-regulated learning and motivation. Participants were 364 undergraduates enrolled in a psychology course at a public university. The demographics of the participants were 269 Caucasian and 95 minorities (43 African American, 6 Asian American, 14 Hispanic, 7 Native American, 25 other). Participants completed the Academic Delay of Gratification Scale and the Motivational Strategies for Learning Scale. Since there were no mean differences between the ethnic groups on the variables being studied, they were combined into one group (minority) to draw comparisons to Caucasian students. The results of the study identified ethnic differences, but the identified differences were not statistically significant.

Since the examination of the relationship between self-regulated learning and ethnic differences is almost nonexistent, additional research examining ethnic differences in relation to students' self-regulation strategies is needed.

Self-regulated learning intervention strategies in math. Several studies found SRL training to be effective whether embedded in a course, offered as a separate course, or offered as a short-term training session. Instructional interventions have positively affected academic outcomes (Bail, Zhang, &Tachiyama, 2008; Pape, Bell, & Yetkin, 2003). McKeachie, Pintrich and Lin (1985) created one of the first undergraduate courses which focused on teaching learning strategies (Bail, Zhang, & Tachiyama, 2008). Literature suggests once students are taught SRL strategies, they are able to self-regulate and be successful in class (Boekaerts, 1997; Pintrich & Gracia 1994).

Math SRL intervention strategies have included cooperative learning (Kramarski & Mevarech, 2003); self-monitoring through homework logs (Bembunetty, 2009); feedback (Labuhn, Zimmerman, & Hasselhorn, 2010) and the use of standardized diaries to stimulate self-reflection (Schmitz and Perels, 2011). Each study found that SRL strategies positively impact math achievement or reasoning in students.

Siegle and McCoach (2007) conducted a study to determine if training teachers in self-efficacy strategies could affect students' performance in a math class. The research was conducted in two phases, with training of teachers being the first phase and implementing the strategies learned by the teachers the second phase. The researchers used a cluster randomized, pre-post test design with 872 5^{th} graders from 15 schools. The schools were randomly assigned to the treatment or control group. The SRL training took place over a 4-week unit of mathematic classes. They found training teachers in specific instructional activities involving self-efficacy practices can increase a student's self-efficacy in math and overall math achievement. The training focused on three areas: teacher feedback – the teacher complimented the student's work, goal setting – activities

that focus students on their performance, and modeling – students observed how peers successfully performed a task. The results indicated that the training was effective in increasing math achievement in students. In addition, the increase in math self-efficacy can be obtained over a short period of time (Siegle & McCoach, 2007). They concluded the following instructional strategies increase a student's self-efficacy: (a) establishing lesson objectives for the day and constantly referring to them throughout the lesson, as well as reviewing the lesson accomplishments the next day; (b) encouraging students to record a new concept they learned each day or something they excelled at doing; (c) encouraging students who are not successful to try harder and relate their lack of success to lack of effort; (d) giving students feedback by complimenting them; and (e) using other students as models to demonstrate, conceptualize and reinforce that it is possible for students like themselves to be successful.

Perels, Dignath and Schmitz (2009) found that it is possible to improve mathematical problem solving and self-regulation competence through a short training in self-regulated learning. Using a pre-post test design, they studied 249 8^{th} graders, across four different German grammar schools. There were four conditions that students were randomly assigned to (a) self-regulation (b) combined training (c) problem solving training and (d) control group (no training). The training consisted of one 90-minute training session after school once a week for six weeks. The study showed the effectiveness of a 6-week training period for 8^{th} grade students to improve their learning competencies. In another study, Ramdass and Zimmerman (2011) found that students who are trained to use a self-correction strategy have higher levels of math performance

than those who receive no training. Once again, training in self-regulation strategies in math may be beneficial to students.

Goal setting, self-monitoring and self-reflection have all been intervention strategies which researchers found positively impacted math performance in students. Travers and Sheckley (2000) found goal setting, as a component of SRL strategies embedded in the math curriculum, increased students' effectiveness in using SRL strategies. Labuhn, Zimmerman, and Hasselhorn (2010) found self-monitoring, using feedback, can improve calibration accuracy and math performance. Furthermore, Schmitz and Perels (2011) found self-monitoring through the use of standardized diaries enhanced the self-reflection process in eighth graders taking a math course. Each of these components of Zimmerman's (2002) self-regulated learning model is incorporated in the self-regulated intervention strategy found in Appendix D.

In conclusion, math achievement has been an issue in the United States for a number of years. While policymakers continue to try to reduce the gap in math achievement through programs and policies, some researchers have already discovered that self-regulated learning increases math achievement (Perels, Dignath , & Schmitz, 2009; Siegle & McCoach, 2007). Using Zimmerman's self-regulated theory as a model to develop an intervention for students in developmental math courses at a community college adds to the body of literature in several ways: (a) very few studies have used self-regulated learning strategies in developmental math courses, (b) researchers have not investigated the effect of SRL strategies on achievement with a math class that meets face-to-face for four weeks, and (c) the study will offer possible solutions for working with the underprepared college student.

CHAPTER 3

METHODOLOGY

Introduction

The methodology of this empirical study is explained in Chapter 3 and includes the research questions and hypotheses, setting, and description of the participants. The researcher will explain the selection process of the participants and describe data collection procedures, research design, and clearly identify variables. The validity and reliability of the instruments used in this study, in addition to the specifics of the data collection procedures, are also presented.

Purpose of Study

The purpose of this quantitative study was two-fold. First, the study was to investigate possible moderator effects of gender, age, and ethnicity on training in self-regulated learning and math achievement and on training in self-regulated learning and metacognition. Second, the study was to examine the effect training in self-regulated learning has on math achievement and separately on metacognition of community college students enrolled in a developmental math course.

Research Questions and Hypotheses

1. Will the effect of training in self-regulated learning on math achievement vary by gender?
2. Will the effect of training in self-regulated learning on math achievement vary by ethnicity?
3. Will the effect of training in self-regulated learning on math achievement vary by age?
4. Will the effect of training in self-regulated learning on metacognition vary by gender?

5. Will the effect of training in self-regulated learning on metacognition vary by ethnicity?
6. Will the effect of training in self-regulated learning on metacognition vary by age?
7. How does training in self-regulated learning impact math achievement of community college students enrolled in developmental math courses?
8. How does training in self-regulated learning impact metacognition of community college students enrolled in developmental math courses?

Some researchers suggest that students who are taught self-regulation strategies learn to overcome their weaknesses and be successful learners (Cleary & Chen, 2009; Glenn, 2010). In addition, literature suggests that there are gender and ethnicity math achievement gaps (Carrell, Page, & West, 2010; Lee, 2012) and that age differences exist in not only metacognition skills (Jacobson & Harris, 2008), but in academic achievement (Hoyert & O'Dell, 2009). Due to this research, the following hypotheses are proposed:

1. The effect of training in self-regulated learning on math achievement will differ by gender, age and ethnicity.
2. The effect of training in self-regulated learning on metacognition will differ by gender, age and ethnicity.
3. Students who use self-regulated learning in developmental math courses at a community college will have higher levels of math achievement when compared to students who do not receive training in self-regulated learning.
4. Students who use self-regulated learning in developmental math courses at a community college will use more advanced metacognition strategies, reported by the MSLQ, when compared to students who do not receive training in self-regulated learning.

Variables

The study had one independent variable and two dependent variables. The independent variable was training in self-regulated learning with two levels: no training of self-regulated learning and training in self-regulated learning. The dependent variables were math achievement measured by the raw score on the final exam and self-reported

metacognition measured by the Motivated Strategies for Learning Questionnaire (MSLQ) assessment scores. The moderator variables consisted of three demographic student variables: gender, ethnicity and age.

Setting

The study was conducted at an urban community college in Virginia. The community college serves approximately 46,000 students across four campuses. The demographic characteristics of the students attending the community college are 40% full-time, 60% part-time, 53% White, 34% African American and 13% other minorities. The average age of students is 27 with 53% of the students between 18 and 24 years of age ("Quick Facts," n.d.). For the purposes of this study, one campus will be selected to strengthen internal validity. The campus serves approximately 12,000 students ("Number of students," n.d.).

Participants

There were 116 community college students who participated in the study. The participants were enrolled in a developmental math course known as Math Essentials (MTE). Participant demographic information was collected from each of the 116 participants using a demographic form. Demographic statistics are presented in Table 3.1. The characteristics of the student population are not necessarily reflective of the campus population, but more reflective of students who take developmental classes with 60.3% African American, 25.9%, Caucasian, 8.6% Multicultural, 2.6 % Asian, 1.7% Puerto Rican and .9% other (Mediterranean). There were four other ethnic groups listed on the demographic form (Mexican, Cuban, Hispanic, and American Indian), but none of the participants identified with these ethnic groups. The ethnicity of the campus population

being studied was 46% African American, 46% Caucasian, 3% Hispanic, 2% Asian, 2% other and 1% American Indian. There were basically an equal number of female and male participants, which is slightly different than the campus distribution of 40% male and 60% female. The two largest age groups were 18-24 (49.1%) and 25-35 (33.6%), which is consistent with the campus population of 50% 18-24 and 50% over 25.

Table 3.1

Participants Demographic Information

Characteristic	Subcategory	f	%
Gender			
	Male	59	50.9
	Female	57	49.1
Total		116	100.0
Ethnicity			
	Black/African American	70	60.3
	Asian American/Pacific Islander	3	2.6
	White (non-Hispanic)	30	25.9
	Puerto Rican	2	1.7
	Multicultural	10	8.6
	Other	1	.9
Total		116	100.0
Age group			
	Under 18	1	.9
	18-24	57	49.1
	25-35	39	33.6
	36-43	5	4.3
	44-50	9	7.8
	Over 50	5	4.3
Total		116	100

Research Design

This true experiment investigated the affect training in self-regulated learning had on metacognition and math achievement of students enrolled in developmental math courses. The study was conducted in two phases with the first phase examining if each of

the demographic variables had a moderator effect on training in SRL and math achievement and independently on the relationship between training in SRL and metacognition. In the second phase, the researcher examined the effect of the independent variable (training in SRL) on the dependent variable, math achievement, as stated in research question seven and on the dependent variable, metacognition, as stated in research question eight.

Although it was preferred for all teachers participating in the study to teach the same MTE unit, there were not enough volunteers for one unit, so teacher participation was requested from all MTE units. MTE teachers who volunteered their class for the study met the following criteria: (a) the class was taught face-to-face (traditional course), (b) the course was offered between January 2013 and May 2013 in a four-week format per unit, and (c) the class covered one of the Math Essentials (MTE) units 1-9 (Appendix A).

MTE classes were offered over a four-week period during the spring 2013 semester. As depicted in Table 3.2, the data for this study were collected over two four-week periods (3^{rd} Term and 4^{th} Term). There were a total of 11 classes participating the 3^{rd} term and five classes participating the 4^{th} term. Each MTE class was bifurcated and students were randomly assigned to the treatment and control group.

Table 3.2

Spring 2013 Schedule for Developmental Math Courses at the Community College

Term	Dates	Units taught
Term 1: 1^{st} 4 weeks	January 7-February 1	MTE 1-8
Term 2: 2^{nd} 4 weeks	February 4-March 1	MTE 1-9
Term 3: 3^{rd} 4 weeks	March 11-April 5	MTE 2-9
Term 4: 4^{th} 4 weeks	April 8-May 3	MTE 3-9

Measurement and Operationalization of Research Variables

Measurements. Motivated Strategies for Learning Questionnaire (MSLQ) and MyMathLab® software were used to measure the dependent variables in this study. The MSLQ measured participants' scores and MyMathLab® software was used to measure the math achievement of students through the use of a 25-item final if the teacher selected not to use paper-pencil format.

MyMathLab®. MyMathLab® from Pearson Education is a comprehensive software package which allows students to work independently as the software identifies deficiencies in student math skill sets. Those skill sets, which should be mastered in each unit, are listed in Appendix A. MyMathLab® software correlates with the textbook used for developmental math courses (units 1-9). The software allows students to take quizzes and a final exam to demonstrate their mastery of specified skill sets. The teacher in the traditional classroom may use MyMathLab® to present quizzes and the final exam to students because the textbook used in the traditional classroom setting correlates to the software.

Final exams are created for each course at the beginning of every semester. Each unit offers a final exam to students on the last day of the course. The final exam is a 25-item exam with one multiple choice question and 24 short answer/problem solving questions. The content of each final exam is determined by the unit in which the student is enrolled. Each question is worth 4 points and students have 2 hours to complete the exam.

The researcher could not find reliability information about MyMathLab®. However, Pearson published a report on efficacy research conducted at colleges and

universities using MyMathLab®. Efficacy is defined by Pearson as the products' ability to have a positive effect on learning by increasing exam scores and retention rates (Speckler, 2012). Included in this report were three, two-year colleges with enrollment over 20,000. The researcher specifically reports data from these colleges because they are in the same category as the college participating in this study.

Each of the three colleges, Hillsborough Community College, Ivy Tech Community College and Riverside Community College reported positive changes in student success and retention from using MyMathLab®. Hillsborough Community College used the software for some Calculus I courses. The college reported an increase of students passing the course by 50% and a retention rate increase from 73.4% to 96.15%. Data from fall 2007 to fall 2009 showed consistent improvement in retention rates at Ivy Tech Community College which uses MyMathLab® in all intermediate algebra classes. The college reported an increase in retention by 12.5% and a 44% decrease in students failing the course (Speckler, 2012). Riverside Community College District uses the software in some beginning algebra courses. Students had higher averages on the final exam than students not using MyMathLab®.

Motivated Strategies for Learning Questionnaire (MSLQ). The Motivated Strategies for Learning Questionnaire (MSLQ) was developed in 1991 by Pintrich, Smith, Garcia, and McKeachie. The development of the instrument has been ongoing -- informally since 1982 and formally since 1986 when the National Center for Research on Improving Postsecondary Teaching and Learning (NCRIPTAL) was funded (Pintrich et al., 1991). The MSLQ is a widely used, self-report instrument designed to assess student motivational orientations and different learning strategies (self-regulated learning) in a

course (Artino, 2005; Duncan and McKeachie, 2005). The original instrument is 81-items and uses a 7-point Likert type scale (1 = not at all true of me and 7 = very true of me). The instrument is divided into two broad sections and consists of 15 subscales (Artino, 2005; Duncan and McKeachie, 2005). The first section consists of six motivational scales and 31 items assessing student goals and values for a course. The second section assesses nine learning strategies using 31 items relating to cognitive and metacognitive strategies and 19 items relating to student resource management. The subscales of the MSLQ are listed in Table 3.3.

Table 3.3

Subscales of the MSLQ

Motivation scales	# of items	Learning strategies scales	# of items
Intrinsic goal orientation	4	Rehearsal	4
Extrinsic goal orientation	4	Elaboration	6
Task value	6	Organization	4
Control of learning beliefs	4	Critical thinking	5
Self-efficacy for learning & performance	8	Metacognitive self-regulation	12
Test anxiety	5	Time/study environmental management	8
		Effort regulation	4
		Peer learning	3
		Help seeking	4
Total items	31	Total items	50

Several researchers have used modified versions of the MSLQ to conduct their studies. Pintrich and De Groot (1990) used 44 items of a 56-item MSLQ given to seventh graders in their study, which became known as the junior high school (JHS) MSLQ version. Liu (2003) used the four resource management subscales of the MSLQ to examine how to design multimedia learning environments to enhance cognitive skills in

middle school students. Brookhart and Durkin (2003) used some items from the self-efficacy for learning and performance subscale to study classroom assessments, student motivation and academic achievement in a high school social studies class. According to Duncan and McKeachie (2005) and Pintrich et al. (1991), the MSLQ 81-item instrument can be used in its entirety or modified so that subscales of the MSLQ are used to evaluate students.

> The fifteen different scales on the MSLQ can be used together or singly. The scales are designed to be modular and can be used to fit the needs of the researcher or instructor. The instrument is designed to be given in class and takes approximately 20-30 minutes to administer (Pintrich et al., 1991, p. 3).

For the purposes of the study, the subscales metacognitive self-regulation and time/study environmental management from the MSLQ were used to assess student learning strategies. The questionnaire was comprised of 20-items, each rated on a 7-point Likert scale ("1= not at all true of me" to "7=very true of me"). These subscales were selected because the treatment focused on these constructs.

The psychometric properties of the MSLQ for reliability are Cronbach alphas .78 for motivational scales and .71 for learning strategies (Pintrich et al., 1991). The Cronbach's alphas for the subscales being used in the study are .79 for metacognitive self-regulation and .76 for time/study environmental management. Cronbach's alphas for each subscale is listed in Appendix B. Pintrich, Smith, Garcia and McKeachie (1993) established predictive validity by correlating the MSLQ sub-scales with students' final course grades. Pintrich et al. (1993) stated that "the coefficient alphas for the motivational scales are robust, demonstrating good internal consistency" (p. 808). Furthermore, the predictive validity of the instrument has been established by several authors. Cook, Thompson and Thomas (2011) evaluated the criterion validity of the

MSLQ by administering the instrument to medicine residents. The study supported the predictive validity of the instrument. Rotgans and Schmidt (2009) found that student motivation and self-regulated learning strategies measured by the MSLQ are based on the learner and are not course specific, therefore, establishing construct and predictive validity.

Operationalization of research variables. ***Training of Self-Regulated Learning.*** Training of self-regulated learning is the independent variable measured by completion of the SRL strategies outlined in the subsequent treatment section of this chapter. Students completing the exercises were considered trained in SRL strategies modeled after Zimmerman's (2002) cyclical model of self-regulation. The SRL training is specific to metacognitive processes (goal setting, self-monitoring and self-reflection). A component of self-monitoring may also include time management which is included in the training session (Appendix D).

Math Achievement. Math achievement is one of two dependent variables in the study. Math achievement was measured by the final raw score on a 25-item final exam. The exam was given the last week of class and was taken paper-pencil or via MyMathLab® depending on the specific class. The final exam is the same for each unit.

Metacognition. Metacognition is a dependent variable measured by two subscales of the MSLQ equating to a 20-item instrument. The alpha levels for each of the scales is .79 and .76 respectively. Participants were given the instrument at the end of the study to measure metacognition.

Age. Participants self-reported age on the demographic information form which was distributed the first day of class (Appendix C). Participants selected one of five

categories: (a) under 18, (b) 18-24, (c) 25-35, (d) 36-43, (e) 44-50 and (f) over 50. Categories were based on previous literature which grouped ages in a similar manner (Butler & Markley, 1993; Jacobson & Harris, 2008).

Ethnicity. Participant ethnicity was self-reported and collected from the demographic information form (Appendix C). Participants selected one of ten categories modeled from the Census Bureau: (a) Black/African American, (b) Asian/Asian American/Pacific Islander , (c) White (non-Hispanic), (d) Hispanic/Latino American/Spanish Origin, (e) Puerto Rican, (f) Mexican/Mexican American/Chicano, (g) Cuban, (h) American Indian/Alaska Native, (i) Multiracial, and (j) Other (United States Census Bureau, 2012).

Gender. Participants self-reported gender as male or female which was collected from the demographic information form (Appendix C).

Developmental Math Placement

Prior to discussing the data collection procedure, understanding how students are placed into development math courses will assist in understanding the math course sequencing at the community college. This section describes the procedure used by this community college to place students in developmental math courses.

Students who enroll at the community college identified in this study are required to take a college placement test if they do not meet one of the following exemption criteria for the math portion of the test: (a) Math SAT score of 520 or greater, (b) ACT score of 22 or greater, (c) completion of college level math with a C or better, or (d) advance placement (AP) credits for math (DMRT, 2010). Students who are not exempt must take the Virginia Placement Test (VPT). The VPT mathematics assessment test

identifies student deficiencies in specific areas. The test places students in the appropriate math unit (1-9) depending on where they are deficient. Once a student is placed in a unit they must complete all other units in chronological order according to their program of study (DMRT, 2010). For instance, a student placed in Unit 5 will progress to Unit 6, and then Unit 7 and so on until Unit 9 is complete. Once Unit 9 is complete, a student can register for college-level math if their program requires it. Some students can stop after Unit 3, others after Unit 5 and others after Unit 9. These three units are the only stopping points for degree seeking students (DMRT, 2010).

Data Collection Procedures

There were several steps to the data collection procedures, to include, class selection, random assignment of participants, completion of demographic forms, and collection of final exam grades and metacognition quizzes. Data collection procedures occurred from March-May in spring 2013. The first step in the data collection process began with an initial letter sent to the Campus Dean of the Languages, Mathematics, and Sciences Department and Math Coordinator explaining the research project and requesting a list of all instructors teaching developmental math for the spring 2013 semester. Once the list of instructors was received, the researcher personally asked all instructors teaching an MTE unit to participate in this research study. A total of 11 MTE teachers volunteered to participate in the study. Several of the teachers taught more than one section of MTE, so there were a total of 11 classes participating the 3rd term and 5 classes participating the 4th term.

The second step of the data collection process included random assignment. Once classes were selected to be a part of the study, students in each classroom were randomly

assigned to either the group that receives no self-regulated training (control group) or the group that receives training in self-regulated learning (treatment group). Random assignments were conducted using computer software called "The Hat" which randomly draws names.

The third step of the data collection process was collecting demographic information and providing instructions to students in the treatment group. On the first day of class, students completed the demographic information form, which included their email address. In addition, students in the treatment group received instructions via email for completing self-regulated learning strategies. The four self-regulated learning exercises were sent to the students through SurveyMonkey®. Detailed information about the treatment is included in the following section. Students in the control group did not receive any additional instruction.

The final step in the data collection process was collecting the final exam grades and metacognition scores. MTE teachers administered the MSLQ to students prior to the final exam. Teachers were asked to write the student's final exam score at the top of the MSLQ quiz prior to submitting it to the researcher.

Treatment. The treatment for this study aims to incorporate all components of Zimmerman's (2002) self-regulated learning model: forethought (goal setting), performance (self-monitoring) and self-reflection in the intervention strategy as oppose to focusing on just one area. The specific assignments are presented in Appendix D. In addition, Table 3.4 offers a blueprint for understanding the SRL exercises.

Students were asked to complete four SRL exercises each week. The exercises and responses were submitted and collected through SurveyMonkey®, excluding the

time management exercise, which was submitted to students as an email attachment. The exercises were repeated for three weeks, with the last week of class reserved for final exam preparation and completion of the metacognition quiz.

The first exercise, goal setting, was presented to students on Sunday of each week and asked to be completed by Monday evening. Students were asked to set their academic goal for the week. On Monday, students were asked to review the good study habits checklist and apply it during the week. Students were also asked to complete a time management schedule for the week. On Friday, students were asked to complete a journal entry, reflecting on their academic goal for the week and set a new goal for the following week. Students were asked to complete the journal entry by Saturday evening. After exercises were collected for the week, students repeated this process for the following two weeks.

The intervention strategy, presented in Appendix D was designed based on the culmination of studies presented throughout the literature, although the majority of the exercises are modeled after SRL intervention strategies presented by Zimmerman, Bonner, and Kovach (1996). The time management exercise, listed as exercise 2 under self-monitoring and time management, was adapted not only from SRL interventions by Zimmerman, Bonner, and Kovach (1996) but also from Bembunetty's (2009) homework log activity used in her study. Bembunetty's (2009) found homework behaviors such as studying alone and the number of hours spent studying is positively correlated with homework completion. The use of a journal entry for the self-reflection exercise was based on Schmitz and Perels (2011) intervention model which used standardized diaries over 49 days to help enhance students' self-reflection strategies.

Table 3.4

Theoretical Blueprint of Self-Regulated Learning Strategies

SRL component	Objectives	Questions/activities	SRL helpful hints
Goal setting: students set a weekly academic goal	Students will identify their goals and establish a plan for accomplishing their goals.	Goal setting exercise (appendix d)	Writing your goals, helps you focus on accomplishing your goals. Review your goals before beginning your homework assignment.
Self-monitoring: students are asked to assess their study habits and time management skills	Students will review a good study habits checklist and apply these habits to their learning	Self-monitoring and time management exercise 1 (appendix d)	Set a time to study every day Ask questions in class when you do not understand a concept. Prioritize your task Say no to distractions
Self – reflection: Students are asked to compare what they observed in self-monitoring to their set goals.	Student will complete a journal entry each week.	Self-reflection exercise (appendix d)	Studying and completing homework is important to obtaining successful quiz grades. If you do not understand assignments ask for help. Review incorrect answers on your quiz and make sure you understand why your answer was not correct. Review your goals and reassess whether any need to be changed based on your quiz grade (ie. Do you need to study more?)

SRL component	Objectives	Questions/activities	SRL helpful hints
Time management: Students are asked to plan their study time for the week	Students will answer questions and complete a study plan for the week.	Self-monitoring and time management exercise 2 (appendix d)	Complete all homework assignments. Establish a quiet place to study. Devote time to study for this course daily.

Note. The blueprint was created and modeled after SRL strategies presented in Zimmerman, B. J., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners: Beyond achievement to self-efficacy.* Washington, DC: American Psychological Association.

To prevent student attrition, extra credit was given by the instructors to all students who participated in the study. In addition, a drawing for a gift card of the student's choice was held once a week for all students participating in the treatment group.

Data Analysis

In this section, the data analysis performed to answer the research questions will be described. The analysis was performed using SPSS statistical software. Research questions one through three are as follows: (1) Will the effect of training in self-regulated learning on math achievement vary by gender? (2) Will the effect of training in self-regulated learning on math achievement vary by ethnicity? (3) Will the effect of training in self-regulated learning on math achievement vary by age? To answer these questions, a multiple regression analysis was performed using an F test to assess the moderator effect of gender on the relationship training in SRL and math achievement. A second regression analysis was performed to assess the moderator effect of ethnicity on the relationship training in SRL and math achievement. A third regression analysis was performed to

examine the moderator effect of age on the relationship training in SRL and math achievement. The analysis was repeated for the second dependent variable, metacognition, to answer the following research questions: (4) Will the effect of training in self-regulated learning on metacognition vary by gender? (5) Will the effect of training in self-regulated learning on metacognition vary by ethnicity? (6) Will the effect of training in self-regulated learning on metacognition vary by age?

Prior to the analysis, dummy coding was used for the three categorical variables, which were also the moderator variables. The categorical variables were coded as follows; gender (1=male, 2=female); ethnicity (1=Caucasian and 2=Minority.); age (1= up to age 24 and 2=over the age of 24) and SRL training (1= training (yes), 2=training (no)).

Since there was no statistically significant moderator effect of gender, ethnicity or age, on the relationship training in SRL and math achievement and training in SRL and metacognition, the researcher proceeded to perform an analysis to answer research questions seven and eight which are as follows: (7) How does training in self-regulated learning impact math achievement of community college students enrolled in a developmental math course? (8) How does training in self-regulated learning impact metacognition of community college students enrolled in a developmental math course?

Simple regression was performed and an F test used to examine the relationship of training in SRL on each of the dependent variables, math achievement and metacognition. The results for questions seven and eight were statistically significant. The findings will be discussed in Chapter 4.

CHAPTER 4

RESULTS

Introduction

The true experiment focused on how self-regulated learning affects math achievement and metacognition. The chapter describes the results of the data analysis organized by eight research questions. The first section of the chapter uses descriptive statistics to present the treatment and control groups followed by data analysis of group mean data for each of the moderator variables (gender, ethnicity, and age) on each dependent variable, metacognition score and final exam score. The second section of the chapter presents data analysis of how self-regulated learning affects math achievement and metacognition by groupings of MTE units.

Treatment and Control Group Participants

The research design allowed for treatment and control groups to be established by bifurcating participating classes. Data were collected across MTE Units 2-5 and 7-8 in an effort to solicit as many participants as possible. Participants were enrolled in one of the MTE units offered the third or fourth week session. The data in Table 4.1 includes participants taking classes the third week (March 11-April 5) and fourth week (April 8-May 3) terms. MTE 2 and 3 had the highest number of participants with 31 and 30 respectively.

These data indicated that participants involved in this study comprised 42% of the MTE sections offered for the spring semester, with 11 of the 26 MTE sections participating in the study for the third four-week session and five of the 22 sections (23%) participating the fourth four-week session. A lower percentage of classes

Table 4.1

Participants by Math Units

Math Unit	*f*	%
2 - Decimals and percents	31	26.7
3 - Algebra basics	30	25.9
4 - First degree equations and inequalities in one variable	13	11.2
5 - Linear equations, inequalities and systems of linear inequalities	21	18.1
7 - Rational expressions and equations	8	6.9
8 - Rational exponents and radicals	13	11.2
Total	116	100

participated the fourth four-week term because most teachers who participated in the study the third four-weeks had the same students the fourth four-weeks making them ineligible to participate. Recruitment of new instructors was required for the fourth four-week term.

As shown in Table 4.2, participants were randomly assigned to the treatment group with division being fairly equal throughout each group. Overall, 56 of the 116 participants received the treatment (training in self-regulated learning) and 60 participants served as the control group.

Table 4.2

Treatment by Math Units

Math Unit	Treatment		Total
	Yes	No	
2 - Decimals and percents	15	16	31
3 - Algebra basics	15	15	30
4 - First degree equations and inequalities in one variable	6	7	13
5 - Linear equations, inequalities and systems of linear inequalities	10	11	21
7 - Rational expressions and equations	4	4	8
8 - Rational exponents and radicals	6	7	13
Total	56	60	116

Dependent Variables

As previously stated, the dependent variable metacognition was measured by total MSLQ score. The MSLQ scores for metacognitive self-regulation and time/study environment management scales are recorded on a 7-point Likert scale. The abbreviated MSLQ is a 20-item questionnaire with the highest possible score being 140 and the lowest being 20. In this study, the mean MSLQ total score was 103.01 as shown in Table 4.3, with the lowest recorded score being 47 and the highest being 140. The data were based on the scores of 104 participants because 12 MSLQ scores were missing.

Table 4.3

MSLQ Mean Score for Participants

Metric		Score
N	Valid	104
	Missing	12
M		103.01
Median		104.50
SD		16.14
Range		93
Minimum		47
Maximum		140

The dependent variable math achievement was measured by final exam scores as shown in Table 4.4. The raw scores on the 25 item final exam were converted to percentage correct and ranged between 37 and 98 with the mean score being 76.95. The possible score on the final exam ranged from 0-100. There were 23 missing final exam scores with 19 of the 23 students withdrawing from class or not qualifying to take the final exam because of low quiz grades. Overall, 20% of the participants did not take the final exam.

Table 4.4

Final Exam Mean Score for Participants

Metric		Score
N	Valid	93
	Missing	23
M		76.95
Median		76.00
SD		13.06
Range		61
Minimum		37
Maximum		98

Regression Assumption Checking

Prior to testing for assumptions, analysis for evidence of outliers was performed. Residuals diagnostics indicated there were six outliers when examining the relationship between training in self-regulated learning and final exam scores. Cook's distance was used to further examine the six outliers. Cook's distance measures the effect the removal of a data point has on the regression solution (Field, 2012). For each of the outlier cases, Cook's distance is not greater than 1, which indicates the points are not influential.

Procedures used to check regression assumptions consist of linearity, homogeneity of variances, normality and independence (Field, 2012). Linearity and homogeneity of variances is checked with a scatterplot of residuals versus predicted Y (Figure 4.1). Normality assumption is checked using a histogram of residuals and normal probability plot of residuals (Figure 4.2 and Figure 4.3). Independence is checked by the Durbin-Watson statistic (Figure 4.4). There were no violations of assumptions.

The same procedures were used to check for regression assumptions using dependent variable metacognition (MSLQ score). Residuals diagnostics indicated six of the 104 cases were outliers. However, none of the six cases had a Cook's distance greater

than one, indicating that the points were not influential. Moreover, casewise diagnostics indicated five of the six cases had an absolute standard deviation less than 2.5, which suggests 99% of the population is within 2.5 SD. The Durbin-Watson statistic was 2.127 (see Appendix E). There were no violations of the assumptions (see Appendix E)

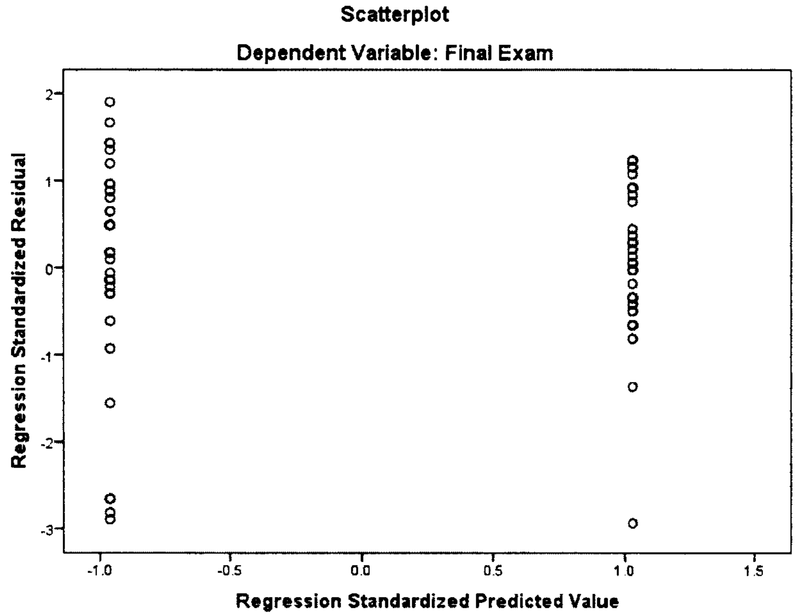

Figure 4.1. Scatterplot: Dependent variable final exam.

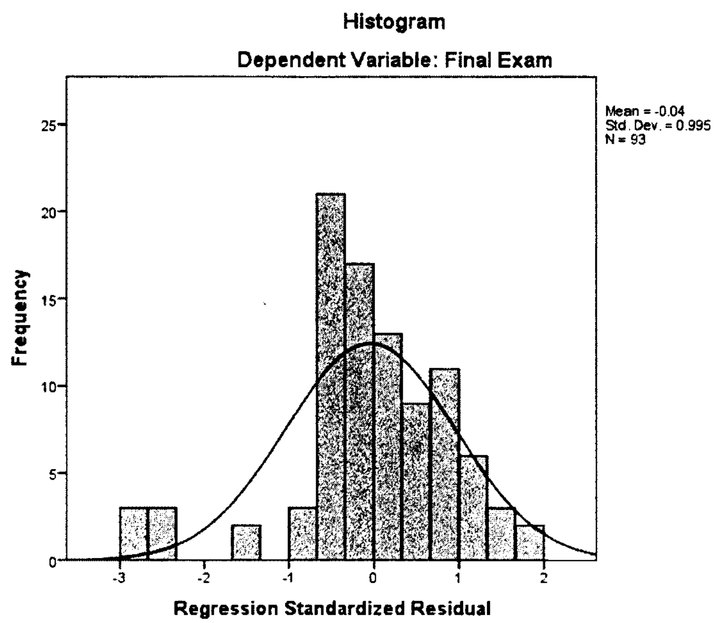

Figure 4.2. Histogram of normality: Dependent variable final exam.

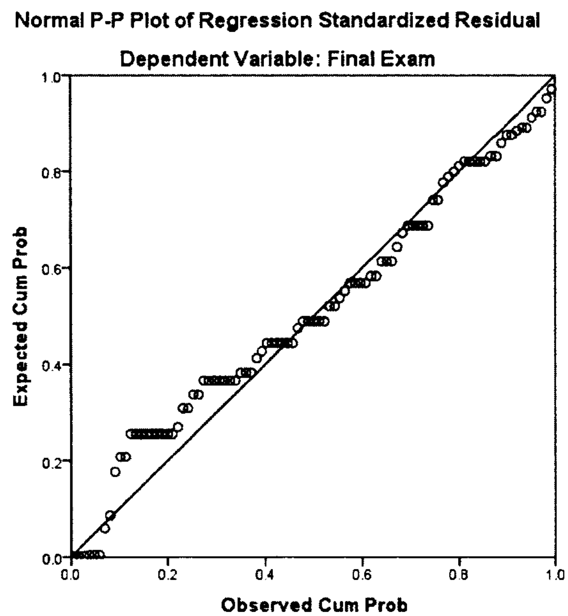

Figure 4.3. Normal P-P plot: Dependent variable final exam.

Checking Independence Assumption					
Model	*R*	R^2	Adjusted R^2	*SE* of estimate	Durbin-Watson
1	.251	.063	.053	12.717	1.902

Figure 4.4. Checking independence assumption.

Missing data. As with many data collection studies, there are instances of missing data. Missing data were most prevalent in relation to the two dependent variables: final exam scores and MSLQ scores. The missing data occurred for one of two reasons when collecting final exam scores, (1) the instructor did not provide the final exam scores to the researcher, after several requests (only four cases) or (2) students did not qualify to take the final exam because of unsatisfactory completion of quizzes or withdrawal from the course (19 cases). As shown in table 4.5, the majority of the 19 missing cases were in the control group and characterized as minority males under the age of 24.

Missing data for the second dependent variable, MSLQ scores, was due to students not being present on the last day of class when the MSLQ was given. Attempts were made to get students to complete the survey through SurveyMonkey®. Although some students responded to the survey, several did not.

Pairwise exclusion was used to account for the missing data, which includes each participant's data set in the analysis except for where data is missing specific to the variable being analyzed. Missing data will be addressed specific to each research question.

Table 4.5

Missing Data by Demographic Variables and Treatment Group

Demographic variable		Treatment	Control	Total
Gender				
	Male	2	13	15
	Female	1	3	4
Ethnicity				
	Caucasian	0	6	6
	Minority	3	10	13
Age				
	Up to 24	2	10	12
	Over 24	1	6	7

Findings by Research Question

Research question 1. The first research question is: Will the effect of training in self-regulated learning on math achievement vary by gender? Multiple linear regression analysis was used to examine if there was a moderator effect across gender. The categorical variable gender was dummy coded as 1 = male and 2 = female. An F test was performed to determine if there was an effect. As presented in Table 4.5, there was little difference in the mean values for females who were in the treatment (M= 81.20) versus

the control (M= 77.89) groups. Though there was a larger difference for males across the groups (M's = 78.00 and 69.27), the variation was not large enough to reach statistical significance. Therefore, a moderating effect for gender was not observed. The results did not suggest that the effect of training in self-regulated learning on math achievement varied by gender, $F(1, 89) = .299, p > .05, \Delta R^2 = .003$.

Table 4.6

Final Exam Mean Values by Gender and Treatment Group

Gender	Group	*M*	*N*	*SD*
Male	Treatment	78.00	22	10.885
	Control	69.27	22	16.205
	Total	73.64	44	14.338
Female	Treatment	81.20	30	8.876
	Control	77.89	19	14.027
	Total	79.92	49	11.137
Total	Treatment	79.85	52	9.805
	Control	73.27	41	15.664
	Total	76.95	93	13.067

Research question 2. The second research question is: Will the effect of training in self-regulated learning on math achievement vary by age? Five age groups were listed on the demographic form for selection by the participant (Appendix C). Due to the low numbers in the age groups, the five groups were collapsed into two groups (up to age 24 and over age 24). Multiple liner regression was performed using SPSS. The variable was dummy coded as 1= up to age 24 and 2=over age 24. As reflected in Table 4.6, the mean values across age groups have little difference. Both age groups have a difference of approximately 6 points where participants in the "up to age 24" group have a mean value of 79.93 compared to the control group (M=73.69). Similarly, "over age 24" treatment

group (M=79.74) showed little difference compared to the control group (M=73.00). Therefore, the results did not suggest that the effect of training in self-regulated learning on math achievement varied by age, $F(1, 89) = .113, p>.05, \Delta R^2=.001$.

Table 4.7

Final Exam Mean Values by Age Group and Treatment Group

Age	Group	*M*	*N*	*SD*
Up to age 24	Treatment	79.93	29	11.010
	Control	73.69	16	16.020
	Total	77.71	45	13.182
Over age 24	Treatment	79.74	23	8.280
	Control	73.00	25	15.759
	Total	76.23	48	13.057
Total	Treatment	79.85	52	9.805
	Control	73.27	41	15.664
	Total	76.95	93	13.067

Research question 3. The third research question is: Will the effect of training in self-regulated learning on math achievement vary by ethnicity? There were 10 ethnicity groups listed on the demographic form (Appendix C). Due to the low numbers in each of these groups, the 10 groups were collapsed into two, Caucasian and Minority. The variable was dummy coded as 1=Caucasian and 2=Minority. Table 4.7 shows the mean values by ethnicity and treatment group. Both ethnicity groups performed somewhat better in the treatment compared to the control group but the mean difference did not reach statistical significance. Caucasians scored 80.71 in the treatment group versus 75.56 in the control group, a mean difference of only 5 points. For minority students the mean difference was somewhat larger at about 7 points (M's = 79.53 for treatment and 72.63 for control). Therefore, a moderating effect for ethnicity was not found. The

results did not suggest that the effect of training in self-regulated learning on math achievement varied by ethnicity, $F(1, 89) = .148, p>.05, \Delta R^2=.002$.

Table 4.8

Final Exam Mean Values by Ethnicity and Treatment Group

Ethnicity	Group	*M*	*N*	*SD*
Caucasian	Treatment	80.71	14	7.680
	Control	75.56	9	16.576
	Total	78.70	23	11.891
Minority	Treatment	79.53	38	10.554
	Control	72.63	32	15.612
	Total	76.37	70	13.462
Total	Treatment	79.85	52	9.805
	Control	73.27	41	15.664
	Total	76.95	93	13.067

Research question 4. The fourth research question is: Will the effect of training in self-regulated learning on metacognition vary by gender? The same dummy coding used in question 1 was used in question 4. As previously stated, the dependent variable, the MSLQ, is a 20-item questionnaire in which five of the questions were reverse coded (Questions 1, 7, 11, 17, and 20) prior to computing the total MSLQ score. The total MSLQ is computed by adding each response (1-7) of the 20 questions together. Multiple linear regression was used to examine if the effect of the independent variable on the dependent variable would vary across gender. As shown in Table 4.8, there was little difference in the mean values for females who were in the treatment (M= 110.17) versus the control (M= 102.05) groups, a mean difference of approximately 8 points. Once again, there was a larger difference for the males across groups (M's = 105.74 and 94.17) at about 11 points, but the difference was not large enough to reach statistical

significance. Therefore, there was not a moderating effect for gender. The results did not suggest that the effect of training in self-regulated learning on metacognition varied by gender, $F(1, 100) = .162, p>.05, \Delta R^2=.001$.

Table 4.9

Metacognition Score Mean Values by Gender and Treatment Group

Gender	Group	*M*	*N*	*SD*
Male	Treatment	105.74	23	15.513
	Control	94.17	29	16.613
	Total	99.29	52	17.000
Female	Treatment	110.17	30	16.463
	Control	102.05	22	9.653
	Total	106.73	52	14.454
Total	Treatment	108.25	53	16.059
	Control	97.57	51	14.464
	Total	103.01	104	16.140

Research question 5. The fifth research question is: Will the effect of self-regulated learning on metacognition vary by age? The same coding was used as mentioned in research question 2. Table 4.9, presents the metacognition score mean values by age group. Participants in the "up to age 24" group scored 106.43 in the treatment group compared to 97.61 in the control group, a mean difference of approximately 9 points. Participants in the "over age 24" group had a slightly larger mean difference of approximately 13 points (M's = 110.61 and 97.54). There was not enough variation to reach statistical significance; therefore, there was not a moderating effect for age. The results did not suggest that the effect of training in self-regulated learning on metacognition varied by age, $F(1, 100) = .553, p>.05, \Delta R^2=.005$.

Research question 6. The sixth research question is: Will the effect of self-regulated learning on metacognition vary by ethnicity? As mentioned in question 3,

Table 4.10

Metacognition Score Mean Values by Age and Treatment Group

Age	Group	*M*	*N*	*SD*
Up to age 24	Treatment	106.43	30	15.869
	Control	97.61	23	12.187
	Total	102.60	53	14.926
Over age 24	Treatment	110.61	23	16.348
	Control	97.54	28	16.322
	Total	103.43	51	17.453
Total	Treatment	108.25	53	16.059
	Control	97.57	51	14.464
	Total	103.01	104	16.140

dummy coding was used for two ethnicity categories. Table 4.10 shows the metacognition score mean values by ethnicity. Caucasians in the treatment group scored 105.71 compared to 93.50 in the control group, about a 12 point difference. Minority participants had a slightly smaller mean difference between groups (M's= 109.15 and 99.11), approximately 10 points. Although both groups performed better in the treatment versus the control group, the variation in the scores were not large enough to reach statistical significance. Therefore, the results did not suggest that the effect of training in self-regulated learning on metacognition varied by ethnicity, $F(1, 100) = .070, p>.05$, $\Delta R^2=.001$.

Research question 7. The seventh research question is: How does training of self-regulated learning impact math achievement of community college students enrolled in a developmental math course? The effect of training in self-regulated learning on math achievement can be further investigated since there was not a moderator effect of gender, age or ethnicity. Simple regression was used to examine the relationship between the

Table 4.11

Metacognition Score Mean Values by Ethnicity and Treatment Group

Ethnicity	Group	*M*	*N*	*SD*
Caucasian	Treatment	105.71	14	14.798
	Control	93.50	14	15.888
	Total	99.61	28	16.299
Minority	Treatment	109.15	39	16.576
	Control	99.11	37	13.804
	Total	104.26	76	16.007
Total	Treatment	108.25	53	16.059
	Control	97.57	51	14.464
	Total	103.01	104	16.140

independent and dependent variable regardless of moderator variables. The results suggest that training in self-regulated learning impacts math achievement, $F(1, 91) = 6.133, p<.05, \Delta R^2=.063$. As shown in Table 4.11, participants in the treatment group had a significantly higher group mean score on their final exam (M=79.85) compared to participants who did not receive the treatment (M=73.27).

Table 4.12

Comparison of Final Exam Group Means by Treatment

Treatment	*M*	*N*	*SD*
Yes	79.85	52	9.805
No	73.27	41	15.664
Total	76.95	93	13.067

Research question 8. The eighth research question is: How does training of self-regulated learning impact metacognition of community college students enrolled in a developmental math course? There was no moderator effect of gender, age or ethnicity based on the relationship of training of self-regulated learning and metacognition, so a simple regression was used to examine the effect training in self-regulated learning has

on metacognition. As demonstrated in Table 4.12, participants receiving treatment had a significantly higher group mean score of 108.25 on the MSLQ compared to participants who did not receive treatment. They had a group mean score of 97.57. The results suggest training in self-regulated learning impacts metacognition of community college students enrolled in a developmental math course, $F(1, 102) = 12.660$, $p<.05$, $\Delta R^2=.110$.

Table 4.13

Comparison of Metacognition Group Means by Treatment

Treatment	*M*	*N*	*SD*
Yes	108.25	53	16.059
No	97.57	51	14.464
Total	103.01	104	16.140

Findings by Math Units

As previously mentioned, data were collected across math units to increase the participant pool. In an effort to better pinpoint differences by math content, analysis of data were examined across specific math units. Math units were combined as shown in Table 4.13 prior to data analysis. Units were combined based on similar math material and level of difficulty being taught in those units. Units two and three were not combined because math was not similar.

A regression analysis was performed to examine how training in self-regulated learning impacts math achievement of community college students enrolled in a developmental math course. Simple regression was performed to examine the data. As shown in Table 4.14, participants receiving treatment in Unit 2 had a final exam group mean score of over 15 points higher than students not receiving treatment, with a final exam group mean score of 81.57 for the treatment group and 66 for the control group.

Table 4.14

Participants by Combined Math Units

Units	Name of unit	*f*	%
2	Decimals and Percents	31	26.7
3	Algebra Basics	30	25.9
4 & 5	First Degree Equations and Inequalities in One Variable/ Linear Equations, Inequalities and Systems of Linear Inequalities	34	29.3
7 & 8	Rational Expressions and Equations/Rational Exponents and Radicals	21	18.1
	Total	116	100

The results suggest training in self-regulated learning impacts math achievement of community college students enrolled in developmental math course Unit 2, $F(1, 24) = 7.305, p<.05, \Delta R^2=.233$.

Unit 3 and the combined unit groups did not have significant results. As reported in Table 4.14, Unit 3 mean score was almost 7 points higher than the control group, but the difference was not significant. The results do not suggest training in self-regulated learning impacts math achievement of community college students enrolled in developmental math course Unit 3, $F(1, 25) = 2.019, p>.05, \Delta R^2=.075$.

The results were the same for the combined Units 4 & 5. The results do not suggest training in self-regulated learning impacts math achievement of community college students enrolled in developmental math course Units 4 and 5 combined, $F(1, 21) = .327, p>.05, \Delta R^2=.015$.

Similarly, there was not a significant difference when examining combined Units 7 & 8. The results do not suggest training in self-regulated learning impacts math achievement and metacognition of community college students enrolled in developmental math course Units 7 and 8 combined, $F(1, 15) = .082$ $p>.05, \Delta R^2=.005$.

Table 4.15

Comparison of Unit Group Final Exam Means by Treatment

Treatment	Units	*M*	*N*	*SD*
Yes	2	81.57	14	9.515
	3	84.36	14	8.608
	4 & 5	77.57	14	7.024
	7 & 8	74.30	10	12.535
	Total	79.85	52	9.805
No	2	66.00	12	18.998
	3	77.54	13	15.592
	4 & 5	74.89	9	15.366
	7 & 8	75.71	7	4.112
	Total	73.27	41	15.664
Total	2 & 3	77.79	53	14.872
	4 & 5	76.52	23	10.808
	7 & 8	74.88	17	9.759
	Total	76.95	93	13.067

Investigation of the relationship between self-regulated learning and metacognition by math units was also performed using regression analysis. Overall, the results were similar to the differences found between self-regulated learning and math achievement by combined math units. As demonstrated in Table 4.15, participants receiving treatment in Unit 2 had higher MSLQ scores compared to the control group but the differences were not significant, $F(1, 25) = 2.928, p = .099, \Delta R^2 = .105$.

Unit 3 participants receiving the treatment had a significantly higher MSLQ score than participants in the control group, reporting a mean score of 112.43 for the treatment group and 100.31 for the control group. The results suggest training in self-regulated learning impacts metacognition of community college students enrolled in developmental math course Unit 3, $F(1, 25) = 5.639, p < .05, \Delta R^2 = .184$

Once again, the other two combined units did not have significant differences. As shown in Table 4.15, the mean score for the treatment groups (M=107.69 and M=105.90) were larger than the control groups (M=99.5 and 99.0), but the differences were not significant. The results do not suggest training in self-regulated learning impacts metacognition of community college students enrolled in developmental math course Units 4 and 5, $F(1, 30) = 1.884, p>.05, \Delta R^2=.059$ or Units 7 and 8, $F(1, 16) = 4.210$, $p=.057, \Delta R^2=.208$.

Table 4.16

Comparison of Unit Group Metacognition Means by Treatment

Treatment	Units	*M*	*N*	*SD*
Yes	2	106.23	13	18.125
	3	112.43	14	14.826
	4 & 5	107.69	16	18.575
	7 & 8	105.90	10	10.939
	Total	108.25	53	16.059
No	2	94.29	14	18.121
	3	100.31	13	11.302
	4 & 5	99.50	16	14.980
	7 & 8	95.00	8	11.526
	Total	97.57	51	14.464
Total	2 & 3	103.31	54	16.899
	4 & 5	103.59	32	17.112
	7 & 8	101.06	18	12.211
	Total	103.01	104	16.140

Summary

Data analyses of the eight research questions were presented. Multiple and simple regression were used to investigate the interaction between training in self-regulated learning and math achievement and also training in self-regulated learning and metacognition. The first six research questions examined moderator variables in relation

to this interaction. Although there were no significant results across the moderator variables (gender, ethnicity and age), there were significant results between the independent variable, training in self-regulated learning and the dependent variables, math achievement and metacognition. Further investigation of the relationship between the independent and dependent variables across combined math units showed statistically significant difference for combined math units one and two. These results along with the limitations of the study will be discussed in chapter 5.

CHAPTER 5

DISCUSSION

Overview

The purpose of this study was to examine the effect training in self-regulated learning has on math achievement and metacognition. In this study, training of self-regulated learning consisted of four exercises, each corresponding with the self-regulated learning phases in Zimmerman's (2002) model. The forethought phase consists of goal setting; participants in the treatment group received a goal setting exercise asking them to set a goal for the week (Appendix D). The second phase of the model is the performance or volitional control phase which includes exercises that encourage students to focus on their learning in the class and provides further instruction on how to self-monitor their learning through time management. Two exercises were provided in this study to assist students through this phase of learning. The self-monitoring checklist and the time management exercise (Appendix D) were used to encourage students to self-monitor their own learning. The third phase of Zimmerman's (2002) model is self-reflection. This phase includes self-evaluation of set goals. Participants were asked to complete a reflection journal (Appendix D) and then set a goal for the upcoming week. Participants in the treatment group were asked to complete the self-regulated learning exercises over a three week period prior to taking their final math exam and metacognition (MSLQ) quiz. Research supports these strategies in terms of student adoption and effectiveness.

In general, the findings of this study are consistent with the central hypotheses. Students in developmental math classes who received training in self-regulated learning strategies were more successful in their math course and self-reported higher metacognitive skills

This chapter provides a discussion about how the treatment in self-regulated learning affected the dependent variables, math achievement and metacognition. This is followed with discussion about the demographic variables and limitations of the study. The chapter concludes with discussion about implications for research and practice.

Treatment Effects on Dependent Variables

Treatment. As previously stated, the treatment for this study consisted of students being introduced to four exercises which align with Zimmerman's (2002) self-regulated learning model. The four exercises comprising the targeted treatment strategy is consistent with the literature. Some researchers found goal setting to be associated with higher academic achievement (Bembenutty, 2009; Peters, 2012). The second and third exercises exposed participants to self-monitoring and time management strategies. Self-monitoring is paying attention to one's learning. Promoting learners to be responsible for their own learning has been linked to academic achievement (Peters, 2012; Schmitz & Perels, 2011). Stegers-Jager and Cohen-Schotanus (2012) found that SRL learning strategies and participation (lecture attendance, skills training, and completion of elective homework assignments) was positively associated with performance of first year medical school students. In addition, Bembenutty (2009) found that time management was positively correlated to midterm exam grades of college freshman taking an introductory math course. The fourth exercise, a self-reflection exercise using journals, has been connected to improved math achievement in the literature (Schmitz & Perels, 2011; Schmitz & Wiese 2006). These SRL exercises were developed based on literature which supports the benefits of self-regulated learning as a documented strategy for improving

math achievement (Kramarski & Gutman, 2006; Mevarech & Fridkin, 2006; Throndsen, 2011).

Treatment effects on math achievement. The researcher hypothesized that participants who use self-regulated learning strategies in a developmental math course at a community college will have higher levels of math achievement compared to participants who do not receive training in self-regulated learning. The hypothesis was substantiated by significant differences in mean final exam score for participants in the treatment group compared to the control group.

The findings are consistent with previous literature that suggested students who are taught self-regulated learning have higher levels of math academic achievement (Kramarski, Weisse & Kololshi-Minsker, 2010; Mevarech & Fridkin, 2006; Perels, Dignath & Schmitz, 2009). A study conducted by Perels, Dignath and Schmitz (2009), found self-regulation strategies can improve math achievement in 6^{th} graders. The participants in the experimental group showed higher levels of mathematics skills in this pre/posttest design than the comparison group. The researchers conducted the quasi-experimental study in which one teacher who administered self-regulated learning to one 6^{th} grade class and not to the other. The study was similar to the present study in that the students were in a three week math class with nine lessons to cover. Eight self-regulation strategies were embedded in the math course and taught in conjunction with the math lessons.

Siegle and McCoach (2007) also conducted a study using a pre-post design with 872 5^{th} graders from 15 classes in a 4-week math class. Self-regulated learning strategies were embedded in the course and resulted in higher levels of overall math achievement

and self-efficacy in math for students receiving training in self-regulated learning compared to those not receiving the treatment.

As previously stated, there is a good deal of literature suggesting that self-regulated learning may positively affect math achievement. However, there is a gap in the research exploring this issue specific to community college students, particularly those enrolled in developmental math courses. Many of the studies conducted with community college students were specific to examining the use of self-regulated learning, but not in relation to math achievement. Williams and Hellman (1998) found a significant relationship between self-regulated learning and overall GPA of first generation community college students, but the study did not target math achievement. Bail, Zhang and Tachiyama (2008) found that college students who took an SRL course were more likely to attain their academic goals and have a higher GPA than students who did not take the course, but again, the study did not target to the community college student and math achievement.

When further investigating the effect of training in self-regulated learning on math achievement by MTE unit, the results varied. Participants in the treatment group significantly outperformed participants in the control groups in math achievement but only in the lower level math unit (Unit 2-Decimals and Percents). Participants in Unit 3 (Algebra Basics) and the higher level math Units 4 & 5 (First Degree Equations and Linear Equations) and 7 & 8 (Rationale Expressions and Exponents), which were combined for this analysis based on similarity of subject matter, did not show significant differences.

The findings for Unit 3 (Algebra Basics) and the combined MTE Units 4 & 5 (First Degree Equations and Linear Equations) and 7 & 8 (Rationale Expressions and Exponents) suggest that students who are in higher level developmental courses already have higher levels of self-regulation strategies, which supports the literature that suggested lower-achieving students tend to display lower levels of SRL strategies (Bol & Garner, 2011; Zimmerman, 2002). Moreover, Bahr (2012) also found that students in lower level developmental courses are less likely to attain their academic goals compared to those in the higher level developmental course. Another explanation for the findings may be that the lower number of participants in the higher level math units did not provide enough statistical power to detect differences as levels increased. Replicating the study with a larger sample of participants in the higher level math units is warranted.

As previously stated, the final exam score group mean difference is a half of a standard deviation overall (.50). Some may suggest the magnitude in difference is not sizeable enough to dedicate resources toward training students in self-regulated learning; however, training in self-regulated learning goes beyond gaining skills to be successful in one math class. Students who are trained in self-regulated learning are able to take these life skills with them along their academic journey and apply these skills toward other subjects. In addition, the final exam score group mean difference for Unit 2 is greater than one standard deviation overall (1.19). This suggests students in the lower level developmental math courses may definitely benefit from training in self-regulated learning.

It is evident that college students, especially community college students enrolled in basic remedial courses should be introduced to self-regulated learning strategies. Since

developmental courses are the gateway courses to many college students attaining their academic goals, it would be wise to consider implementing SRL strategies within the developmental courses at community colleges – especially since community colleges students who need developmental courses, on average, take three (Howell, 2011). More research needs to be conducted in relation to the most effective means for introducing and teaching SRL strategies to students in developmental classes.

Treatment effects on metacognition. Some researchers suggest that students who are taught self-regulation strategies become successful learners in the classroom (Cleary & Chen, 2009; Glenn, 2010). One way to teach self-regulated learning is by designing instruction to correspond with Zimmerman's (2002) cyclical model of self-regulation which guides the learner through three phases: forethought, performance and self-reflection. As learners progress through these phases, they are better able to apply self-regulated learning strategies and learn more about how to control their learning environment (Montalvo & Torres, 2004). Based on the literature, the researcher hypothesized that students who use self-regulated learning in a developmental math course at a community college will have better self-reported metacognition skills compared to students who do not receive training in self-regulated learning. The hypothesis was supported; participants who received the treatment of self-regulated learning had significantly higher scores on the metacognition scale than students who were in the control group and did not receive training in self-regulated learning. The mean MSLQ score for participants receiving treatment was 108.25 compared to 97.57 for participants in the control group.

As noted, self-regulated learning strategies for this study were based on Zimmerman's model which incorporated four exercises associated with each of the three phases: forethought (goal setting exercise), performance phase (self-monitoring and time management exercises), and self-reflection (self-evaluation exercise). Participants completed these exercises weekly for three weeks and took the MSLQ the last day of class to assess their metacognition levels. The findings support the literature which links training in self-regulated learning to higher levels of metacognition (Kramarski and Mevarech, 2003; Yost 2003). When students were introduced to SRL exercises they performed better in their classes than those students who were not introduced to the exercises. The study supports what Zimmerman's model predicts -- all students have the ability to self-regulate, but the degree to which they do differs by student characteristics such as prior achievement (Bol and Garner, 2011). However, if students are taught to self-regulate, particularly lower achieving students, then their ability to be more successful in the classroom may increase.

Zimmerman (1986) and Pintrich (1999) both suggest that metacognition is an important component of self-regulated learning. Metacognition is the ability to control one's learning environment by not only having an understanding of one's learning processes through deliberate monitoring, but being able to adjust one's learning based on this knowledge (Vukman, 2012). Metacognitive strategies are used throughout the three phases of SRL, but are more closely linked to the forethought and performance phase in which learners are encouraged to set goals and monitor their learning through exercises (Ramdass & Zimmerman, 2011). Literature suggests that SRL strategies may include

calibration, goal setting, metacognitive training or self-metacognitive questioning (Cho, 2004; Ramdass & Zimmerman, 2011).

Some studies suggest that metacognition can be taught and can assist students in being better students in the classroom. Kramarski and Mevarech (2003) studied metacognitive training and found that students who received the training outperformed students who did not receive this training. Bol et al. (2012) examined calibration in group settings as an SRL strategy and found using calibration with guidelines in a group setting increased students' ability to accurately predict their test scores. The present study further supports the effectiveness of teaching SRL strategies to improve metacognition and promote achievement. If underprepared students or students who struggle with learning do not have the metacognition skills necessary to be successful in the classroom they may not attain their academic goals.

The effect of training in self-regulated learning on metacognition was further examined by MTE units as well. Overall, the findings varied by MTE unit. Significant differences by group were found for MTE Unit 2 (Decimals and Percents) but not for combined MTE Units 4 & 5 (First Degree Equations and Linear Equations) and 7 & 8 (Rationale Expressions and Exponents). As suggested, the small numbers in the more advanced, units may have impacted the results. Replicating the study with inclusion of more participants in the higher level MTE units would be advantageous. Another option would be to increase the number of subscales used for scoring learning strategy skills. Only two of the 15 subscales of the MSLQ were used to test metacognition skills. Since several learning strategy skills are needed to advance to the higher level math classes, conducting research using some or all of the other four learning strategy subscales

(rehearsal, elaboration, organization and critical thinking) may offer different results and more in-depth research in this area.

Demographic Variables

The researcher hypothesized that the effect of training in self-regulated learning on math achievement and metacognition would vary by gender, age and ethnicity. The hypothesis was not supported; there was no moderator effect for any of the demographic variables. Gender, age and ethnicity did not vary when examining the relationship between self-regulated learning on each dependent variable: math achievement and metacognition.

Gender. It is plausible that treatment effects may differ by gender. Several studies have shown that females tend to use more self-regulated learning skills than males (Bezzina, 2010; Ray, Garavalia, & Gredler, 2003; Zimmerman & Martinez-Pons, 1990). Ray, Garavalia & Gredler (2003) reported college females not only exhibited more SRL strategies, but academically outperformed college males as well. Although females may academically outperform males in some subjects, other researchers found that males academically outperform females. Carrell, Page, and West (2010) posited that males academically outperform females in math, especially in the higher level math. Using this body of literature as background, it was thought that the target treatment for underprepared college students taking lower level math courses might have been more effective for females versus males. However, the results suggested there was not a moderator effect of gender on the relationship between training in SRL and each of the two dependent variables, math achievement and metacognition.

Although the results were not anticipated by the researcher the literature reflects mixed findings with respect to gender differences in SRL. Bembenutty (2007) did not find statistically significant gender differences among college students when examining the relationship between SRL and academic delay of gratification. In addition, Bidjerano (2005) conducted a study with 198 undergraduate students and found no statistically significant gender differences on the MSLQ subscales help seeking, critical thinking and peer learning. However, on six other MSLQ subscales (rehearsal, organization, metacognition, time management skills, elaboration, and effort), females reported using these strategies at a statistically higher level than males. Since SRL can incorporate several components, studies which consistently compare the same subscales are rare. Perhaps this study could be replicated using additional subscales to include motivational levels and additional metacognition scales in an effort to determine if gender as a moderator effect exists when metacognition is defined more broadly.

Age. Literature suggests that adult learners, also referred to as nontraditional students, have higher levels of metacognition because of their depth of experiences (Hoyer & O'Dell, 2009). Adult learners for this study were defined as age group "over the age 24" and traditional students were defined as age group "up to age 24". The literature supports the prediction that adult learners spend more time studying than nontraditional students (Adams & Corbett, 2010) and they generally maintain higher GPA's than traditional students (Hoyert & O'Dell, 2009). These studies reinforce the notion that there are age differences based on study habits, academic achievement and metacognition skills. For instance, Jacobson and Harris (2008) found significant differences between traditional and nontraditional students on three of the strategies for

the MSLQ learning subscales (elaboration, critical thinking, and metacognitive self-regulation) with nontraditional students having higher levels than traditional students.

Based on the literature, the researcher postulated there would be a moderator effect of age on the relationship between training in SRL and math achievement and training in SRL and metacognition. However, the findings indicated that age did not moderate this relationship.

There may be several reasons why there was not a moderator effect found in this study. First, there is a lack of research specific to age differences related to training in SRL. Second, perhaps adult learners in lower level developmental courses exhibit the same deficiencies as traditional students; therefore, there is little variance in metacognition level and academic achievement. Last, the small sample size of this study may have impacted results. Unlike the 806 undergraduates examined in the Jacobson and Harris (2008) study, we had only 116 participants which diminished the statistical power to detect differences. Further investigation of age differences on SRL interventions is warranted, given the gap in the literature in this area.

Ethnicity. Ethnicity did not moderate the relationship between training in SRL and math achievement. Literature suggests there is a math achievement gap between Caucasian and minority students, which becomes more pronounced in college (Hyde et al., 1990; Lee, 2012). In addition, researches posited that Caucasian students academically outperformed African American and Hispanic students in math (Riegle-Crumb & Grodsky, 2010). Although this is the case, the results of this study suggest that ethnicity does not vary on the relationship between math achievement and training in SRL.

It is not necessarily surprising that there was not a moderator effect on ethnicity for two reasons. One, researchers suggests there are several other variables, in addition to SRL strategies, which may impact student academic performance across ethnicity, such as self-efficacy, math anxiety, parent's education and socioeconomic background (Grogan-Kaylor & Woolley, 2010; Fast et al., 2010; Roth, 2002). Second, the research in this area is extremely limited. Bembenutty (2007) did not find significant differences in relationship between SRL strategies and ethnicity. The lack of research in this particular area suggests there is much more room for additional research examining the relationship between ethnicity and SRL strategies.

Limitations

As with any study, there are limitations to internal and external validity. Limitations to this study included threats to internal and external validity such as self-report instruments, problematic collection data procedures, small class sizes, volunteer bias, and generalizability.

There were limitations with using the MSLQ in this study. The MSLQ questionnaire is a self-report measure, so social desirability bias and accuracy of reporting may affect validity. Students may have answered according to what is seemingly viewed as favorable instead of accurate. Young and Ley (2005) reported that developmental students tend to exaggerate their use of self-regulatory strategies. Findings rely on students to accurately and honestly report their implementation of self-regulated learning strategies. In addition, although random selection was used in this study to minimize differences between groups, the current level of participants' metacognitive

skills was not assessed. Future studies may consider using a metacognitive pretest in addition to a posttest in order to determine growth in this particular area.

Attrition was another limitation to this study. The researcher anticipated that several students would withdraw from classes based on not only research indicating that developmental math courses have one of the highest withdrawals rates (Adelman, 2004), but also procedures pertaining to the college's add, drop and withdrawal period. A total of 19 students withdrew or failed their developmental math course and, therefore, did not complete the final exam or the MSLQ quiz. Sixteen of the 19 students were in the control group (84%), which suggests there may be a relationship between training in self-regulated learning and math achievement and retention. The findings support Le, Rogers and Santos (2011) who suggested students are more likely to fail a developmental math course than any other course in college. Training in SRL may have affected retention since a larger portion of the students who dropped out were not receiving the training.

The researcher anticipated addressing the attrition issue with a large sample size. However, the sample size was smaller than anticipated for two reasons. First, the researcher assumed more teachers would volunteer their class to participate. The lack of teacher volunteers impacted the overall number of participants. Second, as developmental math courses continue through the spring semester, fewer students overall are taking a developmental math course. Data collection began in the middle of the spring semester with the last two sessions of developmental math units being offered (third and fourth week sessions). By this time, many students who started with the developmental math sequence the first four week session had either completed their math units, withdrew

from the math units, or failed the math units, resulting in a smaller pool of possible participants.

Another major limitation of the study was data for the study were collected at one community college. This limits the external validity of the study, making it less generalizable. The reason for limiting this study to one community college is because community colleges have different practices and policies regarding developmental education which can impact the internal validity of the study. In addition, the study is specific to the state of Virginia and one of the first that will be conducted using the newly designed math courses.

The results might generalize to an urban campus with a student population of approximately 12,000 students. The campus in this study had 60% female and 40% male students. The ethnicity of the students was 46% African American, 46% Caucasian, 3% Hispanic, 2% Asian, 2% other and 1% American Indian. In addition, 50% of the students were over the age of 24 and 50% were under the age of 24.

The length of the treatment may have been a limitation as well. The treatment was given over a four-week period; however, research supports the use of short training sessions for SRL strategies. Siegle and McCoach (2007) conducted a study over a four-week unit of math classes and reported statistically significant results. In addition, Perels, Dignath and Schmitz (2009) used a six-week training period of SRL strategies and also reported statistically significant results.

Volunteer bias was a limitation to this study as well. MTE classes that participated in this study were based on the teachers' willingness to volunteer their class to participate. The researcher faced challenges in recruiting all MTE teachers to

participate in the study. Solicitation to participate in the study was sent from the Dean of the Languages, Mathematics, and Sciences Department, the coordinator of MTE classes and the researcher; however, several classes still decided not to participate in the study for reasons not communicated to the researcher. Ten of the 26 MTE sections volunteered for the study the third four-week session and five of the 22 sections participated the fourth four-week session. The teachers, who volunteered their classes for the study, may be better instructors in the division and are more open to allowing outsiders to collect data from their students. .

Implications for Research

Little research examines the relationships between self-regulated learning and math achievement in community college students enrolled in a developmental math course. However, there continues to be much conversation about the increase in the number of students attending community colleges and the increased number of students needing to take developmental courses in order to attain their academic goals (Virginia Community College Systems, 2012). The positive relationship between self-regulated learning and academic outcomes are evident throughout the literature. Studies have focused on elementary school students (Beilock et al., 2010; Speybroeck et al., 2012; Throndsen, 2011), middle school students (Perels, Dignath & Schmitz, 2009), and high school students (Bol et al., 2012; Kramarski & Gutman, 2006). The studies which focus on SRL strategies in college students tend to be related toward more advanced course subjects such as organic chemistry (Lynch & Trujillo, 2011) or engineering (Kane et al., 2004). Studies examining SRL specific to community colleges students or underprepared students is limited, yet, researchers suggest that students who are lower achieving or

underprepared are less likely to possess the SRL skills needed to be successful in their college courses (Ley & Young, 1998; Isaacson & Fujita, 2006). There is opportunity for further examining the relationship between SRL and math achievement across different math strata or observing the relationship between SRL strategies and other developmental courses, such as English.

Another potentially fruitful research direction is the relationship between achievement in developmental math courses and self-efficacy. Several studies positively link self-efficacy and math achievement (Fast et al., 2010; Hanlon & Schneider, 1999). Wilmer (2008) suggested underprepared students have issues with motivation and self-esteem. Exploring this relationship by examining another component of self-regulated learning in addition to metacognition may assist with a more comprehensive understanding of the factors which impact math achievement in community college students enrolled in a developmental math course.

Further research can also be conducted with respect to demographics variables which were explored in this study. Research suggests there is a math achievement gap between males and females (Bezzina, 2010), Caucasian and minorities (Riegle-Crumb & Grodsky, 2010) and nontraditional and traditional students (Riegle-Crumb & Grodsky, 2010). Although this study did not find significant results in these areas, additional research using a larger sample size and more subscales to not only measure metacognition but to examine motivation across these demographic variables may offer additional insight to establishing successful learning strategies for the underprepared student.

Implications for Practice

Math achievement gaps start as early as kindergarten and become more pronounced in high school (Hyde et al., 1990; Penner & Paret, 2008). These same gaps follow students to college often resulting in underprepared students taking a series of developmental education courses in order to attain their academic goals (Bahr, 2008). There is an increase in the number of underprepared students entering community colleges; Virginia Community College System had over 57% of students entering college in fall 2007 needing to take a developmental math course (Virginia Community College Systems, 2012). College administrators continue to have discussions about how to help underprepared students successfully complete developmental courses. Montalvo and Torres (2004) suggested that self-regulated learning can assist students in becoming more successful in the classroom, particularly in math.

The study suggests that training in self-regulated learning helps students to become more successful learners in the classroom. Since the number of students taking developmental classes is increasing, it would be beneficial for executive level college administrators to begin evaluating developmental courses beyond method of delivery and consider how student learning impacts their progression through these courses.

As discussed in the literature, developmental math courses have one of the highest withdrawal rates at colleges (Adelman, 2004). This was affirmed in this study as 16% of students withdrew or failed their developmental class; therefore, not qualifying to take the final exam. If faculty who teach developmental courses began to embed self-regulated learning in their courses, they may increase students' success in the course. Literature supports training teachers to embed self-regulated learning in their class (Montalvo &

Torres, 2004). Moreover, some literature also supports self-regulated learning as a separate class (Bail, Zhang, & Tachiyam, 2008). In either case, exploring self-regulated learning as a four-week class, alongside of the developmental courses or as a series of workshops, may help students become more focused on their learning while they are in the classroom.

Fike and Fike (2008) posited that students do not have the necessary study skills to perform well in developmental courses. Yet, Bembenutty (2010) suggested that self-regulated learning can be taught and may assist students with passing challenging courses. Jones and Byrnes (2006) add to the discussion by suggesting that teaching students to self-regulate may assist those who are likely to withdraw from a developmental course because they lack motivation or self-efficacy. Several studies support the idea that self-regulated learning strategies increase math achievement because students were taught how to adjust their learning (Kramarski & Gutman, 2006; Perels, Dignath & Schmitz, 2009). Since studies have shown that students who pass developmental courses are just as likely to attain their academic goals as those who do not have to take developmental courses, it would behoove administrators to examine ways in which students can successfully complete these courses (Bahr 2008; Bettinger & Long, 2009). The instruction of self-regulated learning is purposeful and can be designed to align with the course subject being studied.

Conclusion

The purpose of this study was to examine the effect training in self-regulated learning has on math achievement and metacognition. Training in self-regulation learning strategies was found to have a significant effect on math achievement and metacognition;

although there were not significant results when examining the relationship across demographic variables gender, age and ethnicity.

The findings point to a potential solution to decreasing the number of students withdrawing from developmental math courses. Many initiatives directed at assisting students to successfully complete the developmental math sequence at the community college has been focused on course delivery changes, such as requiring students to only take math units that are applicable to their specific degree, take courses only in the areas in which the student is deficient, and change the delivery method of the course so that students are able to complete the sequences quicker. While these strategies may help address the problem, another promising solution may be embedding the SRL strategies within the developmental courses so that students who have yet to learn how to self-regulate their learning have the opportunity to do so at this stage in their education. Literature suggested that students with lower level achievement typically have lower levels of SRL (Bol & Garner, 2011; Ley & Young, 1998; Zimmerman, 2002). Teaching the student how to learn may not only increase completion rates within developmental courses, but completion rates at the community college. Self-regulated learning is a life skill that can help students who otherwise might not have the opportunity to attain their academic goals.

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APPENDIX A

DEVELOPMENTAL MATH LEARNING COURSE CONTENT (UNITS 1-9)

Unit name	Unit description	Course outcomes
Unit 1	Operations with Positive Fractions	1.1 Write, simplify, and compare fractions. 1.2 Perform operations with fractions. 1.3 Solve applications using U.S. customary units of measurement.
Unit 2	Operations with Positive Decimals and Percents	2.1 Demonstrate the meaning of decimal numbers. 2.2 Perform operations with decimals. 2.3 Estimate decimals. 2.4 Demonstrate the relationship among fractions, decimals, and percents. 2.5 Solve basic percent problems. 2.6 Read and interpret basic graphs. 2.7 Convert units of measure. 2.8 Solve application problems using U.S. customary and metric units of measurement.
Unit 3	Algebra basics	3.1 Determine the absolute value of a number. 3.2 Demonstrate proper use of exponents. 3.3 Find the principal square root of a perfect square. 3.4 Simplify expressions involving signed numbers. 3.5 Write numbers in scientific notation. 3.6 Simplify algebraic expressions. 3.7 Evaluate a formula or algebraic expression for given values of the variables. 3.8 Solve one-step equations using the addition and multiplication properties. 3.9 Solve problems using proportions. 3.10 Solve application problems including finding perimeter, area and volume.

Unit name	Unit description	Course outcomes
Unit 4	First Degree Equations and Inequalities in one variable	4.1 Solve first degree equations in one variable. 4.2 Solve a formula or equation for one of its variables. 4.3 Solve first degree absolute value equations containing a single absolute value. 4.4 Solve first degree inequalities in one variable. 4.5 Solve application problems using a single first degree equation or inequality.
Unit 5	Linear Equations, Inequalities and Systems of Linear equations in Two Variables	5.1 Define the properties of the rectangular coordinate system. 5.2 Graph a linear equation in two variables. 5.3 Graph a linear inequality in two variables. 5.4 Find the slope of a line. 5.5 Write an equation of a line. 5.6 Solve systems of linear equations. 5.7 Use function notation. 5.8 Solve application problems that require linear equations, inequalities and systems of linear equations in two variables.
Unit 6	Exponents, Factoring and Polynomial Equations	6.1 Perform operations on exponential expressions using the rules of exponents. 6.2 Define, add, subtract, multiply and divide polynomials. 6.3 Factor polynomials. 6.4 Solve polynomial equations using factoring techniques. 6.5 Solve application problems involving polynomial equations and factoring.
Unit 7	Rational Expressions and Equations	7.1 Identify a rational algebraic expression. 7.2 Simplify rational algebraic expressions. 7.3 Perform arithmetic operations with rational algebraic expressions. 7.4 Solve rational algebraic equations. 7.5 Solve application problems using rational algebraic equations.

Unit name	Unit description	Course outcomes
Unit 8	Rational Exponents and Radicals	8.1 Demonstrate the equivalence of radical and rational exponent forms. 8.2 Compute and estimate radicals. 8.3 Simplify radicals and radical expressions. 8.4 Perform operations (add, subtract, multiply) on radicals and radical expressions. 8.5 Rationalize the denominator (one term and two terms). 8.6 Solve radical equations. 8.7 Define the imaginary unit and imaginary numbers. 8.8 Simplify square roots of negative numbers using the imaginary unit. 8.9 Solve application problems involving radicals.
Unit 9	Functions, Quadratic Equations and Parabolas	9.1 Determine if a relation is a function and identify the domain and range of the function. 9.2 Find all roots of quadratic equations using both the square root method and the quadratic formula. 9.3 Analyze a quadratic function to determine its vertex by completing the square and using the formula. 9.4 Graph a quadratic function, using the vertex form, indicating the intercepts and vertex. 9.5 Apply knowledge of quadratic functions to solve application problems from geometry, economics, applied physics, and other disciplines.

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APPENDIX B

COEFFICIENT ALPHAS OF THE MSLQ SUBSCALES

Scale	Corresponding item #s	Alpha
Motivation scales		
Value component:		
Intrinsic goal orientation	1, 16, 22, 24	.74
Extrinsic goal orientation	7, 11, 13, 30	.62
Task value	4, 10,17, 23, 26, 27	.90
Expectancy component:		
Control of learning beliefs	2, 9, 18, 25	.68
Self-efficacy for learning & performance	5, 6, 12, 15, 20, 21, 29, 31	.93
Test anxiety	3, 8, 14, 19, 28	.80
Learning strategies scales		
Rehearsal	39, 46, 59, 72	.69
Elaboration	53, 62, 64, 67, 69, 81	.75
Organization	32, 42, 49, 63	.64
Critical thinking	38, 47, 51, 66, 71	.80
Metacognitive self-regulation	33R, 36, 41, 44, 54, 55, 56, 57R, 61, 76, 78, 79	.79
Resource management strategies scales		
Time and study environment	35, 43, 52R, 65, 70, 73, 77R, 80R	.76
Effort regulation	37R, 48, 60R, 74	.69
Peer learning	34, 45, 50	.76
Help seeking	40R, 58, 68, 74	.52

Note. R means the item is reversed coded. Pintrich, P.R., Smith, D.A., Garcia, T., & McKeachie W.J. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ). National Center for Research to Improve Postsecondary Teaching and Learning. Ann Arbor: University of Michigan.

APPENDIX C

DEMOGRAPHIC INFORMATION FORM

Email Address____

Please answer the following questions.

1. Gender: Male Female

2. Ethnicity:

a. Black/African American	b. Asian/Asian American/Pacific Islander
c. White (non-Hispanic)	d. Hispanic/Latino American/Spanish Origin
e. Puerto Rican	f. Mexican/Mexican American/Chicano
g. Cuban	h. American Indian/Alaska Native
i. Multiracial	j. Other ____________________

3. Age:

a. under 18	b. 18-24	c. 25-35
d. 36-43	e. 44-50	f. over 50

APPENDIX D

SELF-REGULATED LEARNING STRATEGIES (TREATMENT)

I. GOAL SETTING EXERCISE

Goals are accomplishments you want to reach. You may set goals so that you know your purpose and motivation for undertaking a specific activity. Some goals are long-term while others are more immediate or short-term goals. Set an academic goal for the week specific to this math course. For example you may say "my goal is to make sure I understand the topic being discussed", or "my goal is to study at least two hours a day for the class", or "my goal is to increase the number of questions I ask when I don't understand something."

After you set your academic goal, list specific steps you will take to accomplish this goal. For example, "I will designate one hour a day to study for this class", or "I will read the syllabus and list all assignments in my calendar."

My Academic Goal for this week is
Steps I will take toward accomplishing my goal for the week
1. 2. 3. 4. 5.
I met my goal for the week (YES or NO) (Circle One) If you did not meet your goal, please list the reasons why below?

II. SELF-MONITORING AND TIME MANAGEMENT EXERCISES

Exercise 1

Practice the following good study habits checklist so that it becomes a daily habit for you.

Before Class

_______Read the syllabus prior to going to class today

_______List all assignments that are due this week

_______Schedule time to work on the assignments during the week

<u>During Class</u>

_______List the topic for today's lesson

_______Ask questions if you do not understand

_______Do not be distracted during class time

<u>After Class</u>

_______Review your notes after class to make sure you understand the concepts

_______List the concepts you understand

_______List the concepts you do not understand

_______If necessary, meet with the teacher or other classmates to help you understand the topic being discussed.

Exercise 2

Complete your study plan for the week by completing the weekly schedule below. Include class time, study time, leisure time, sleep time, etc. Make sure you include 2 hours of study time for every credit hour you are taking this semester. For example, if you are taking 12 credit hours you should have 24 hours of study time listed on your calendar. Try and stick to your study schedule. (This exercise will be repeated once a week for three weeks).

WEEKLY SCHEDULE							
	MON	TUES	WED	THURS	FRI	SAT	SUN
6:00 AM							
7:00 AM							
8:00 AM							
9:00 AM							
10:00 AM							
11:00 AM							

12:00 PM							
1:00 PM							
2:00 PM							
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5:00 PM							
6:00 PM							
7:00 PM							
8:00 PM							
9:00 PM							
10:00 PM							
11:00 PM							
12:00 AM							

III. SELF-REFLECTION EXERCISE

Review your goal for this week. Complete a journal entry.
As you reflect on the lessons for the week, please answer the following questions when completing your journal entry. Did you understand the lessons for the week? If not, what did you do to help gain more understanding?

What did you score on your quiz? Were you satisfied with the grade? If not, what can you do to improve your grade? If you missed a question, how will you make sure you understand the questions you missed on the quiz?

Revaluate your goal and consider what you need to do to accomplish your goals. For example, you may need to study more, complete homework assignments, ask more questions, get help from your teacher or find a quiet place to study.

After you have completed this exercise, set your academic goal for week 2.

APPENDIX E

ASSUMPTION CHECKING OUTPUT (MSLQ)

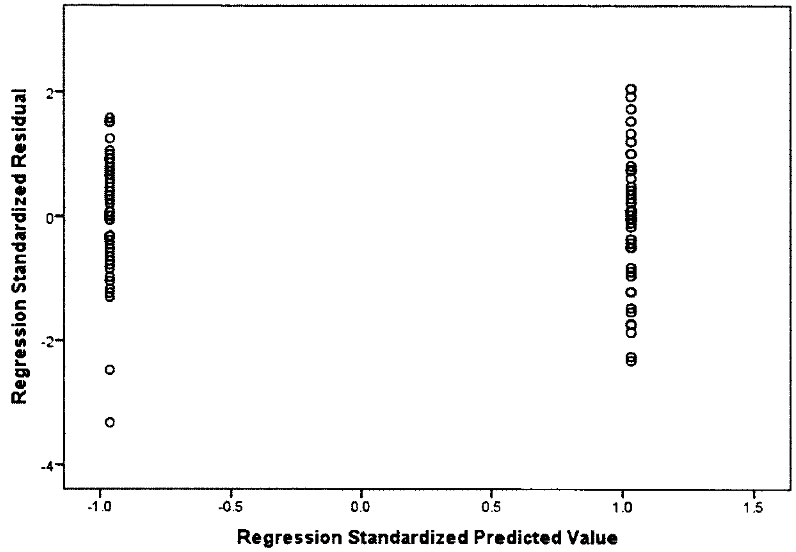

Figure E.1. Scatterplot of dependent variable: MSLQ total.

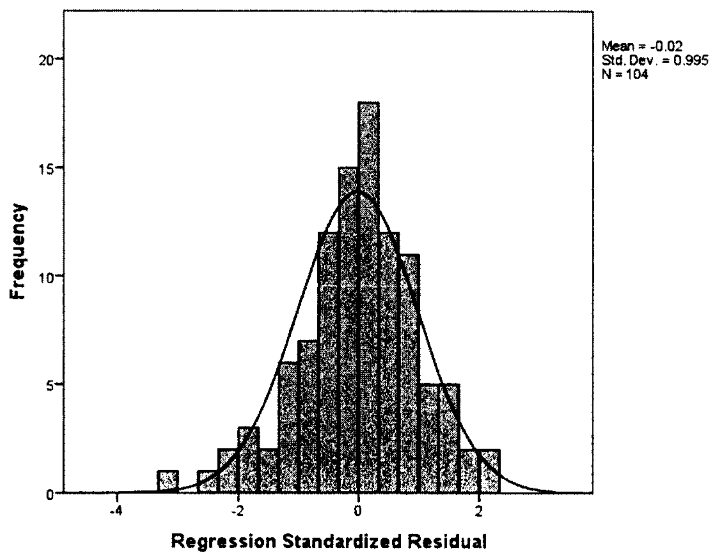

Figure E.2. Histogram of dependent variable: MSLQ total.

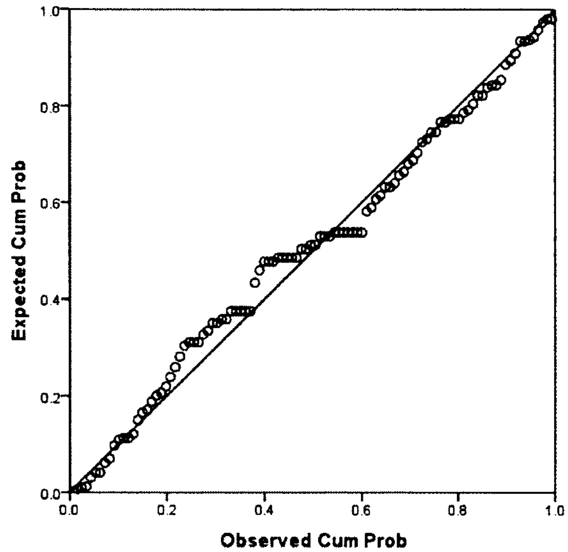

Figure E.3. Normal P-P plot of regression standardized residual dependent variable: MSLQ total.

Checking Independence Assumption: MSLQ Score

Model	*R*	R^2	Adjusted R^2	*SE* of estimate	Durbin-Watson
1	.332	.110	.102	15.298	2.127

Figure E.4. Checking independent assumption: MSLQ score.

VITA

Karen D. Y. Campbell

Darden College of Education, Higher Education Program
Old Dominion University, Education Building, Room 120, Norfolk, VA 23529-0157

EDUCATION

Old Dominion University, Norfolk, VA
Ph.D. in Higher Education, August 2013

James Madison University, Harrisonburg, VA
Master of Education in Counseling Psychology, College Student Personnel Administration, May 1993

University of Richmond, Richmond, VA
Bachelor of Science in Business Administration, May 1991

HONORS AND AWARDS

- Outstanding Doctoral Student in Higher Education (May 2013)
- Phi Kappa Phi Honor Society
- Golden Key International Honour Society
- Recipient of the Chancellor's Fellowship (2011-2012)

TEACHING EXPERIENCE

- Adjunct Faculty – Orientation to Healthcare (SDV 101), Tidewater Community College, Portsmouth, VA
- Adjunct Faculty – College Success Skills (SDV 100), Tidewater Community College, Portsmouth, VA
- Career and Life Planning (BIS 200) - James Madison University, Harrisonburg, VA

PROFESSIONAL EXPERIENCE

Career Coach, *Tidewater Community College*, Norfolk, VA (3/2005-present)

Associate Director of the Career Center, *The College of William and Mary*, Williamsburg, VA (7/2000-3/2005)

Career Specialist, Academic Advising and Career Development, *James Madison University*, Harrisonburg, VA (merger) (7/1/98 – 6/30/00)

Assistant Director of Career Services, *James Madison University*, Harrisonburg, VA (4/95-7/1/98)

Career Counselor, *Emory University*, Atlanta, GA (7/93-3/95)

PUBLICATIONS

Campbell, K. (2013). Book Review: Save the World on Your Own Time. *Academic Perspectives in Higher Education*, 5-11.